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Our Changing Standards

. . . When the submarine S-4 was rammed by a destroyer and sent to the bottom, a whole nation anxiously watched the attempts to rescue the six men known to be alive in her bow compartment. When rescue failed, the general and natural sentiment was that death in the collision, or a comparatively swift death by drowning, would have been infinitely more merciful than the slow tortures of suffocation.

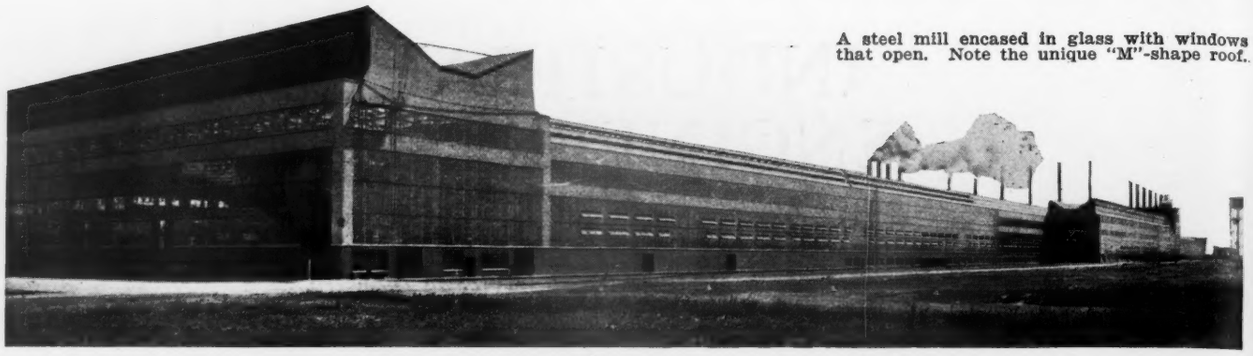
. . . And yet, it is not so very long ago that human beings—in the Crimean War, and even in our own Civil War—were thrown into prisons where scores and even hundreds were permitted to die that same cruel death of suffocation because of inadequate ventilation.

. . . It is easy to say that our humane standards have advanced. They have, undoubtedly; but why?

. . . Why is it, for example, that we no longer tolerate working conditions that were an accepted commonplace only a few decades ago? The dictates of humanity were quite as strong, fifty or a hundred years ago, or twenty years ago, as they are today. The poets, philosophers, social reformers, were even more denunciatory of man's inhumanity to man than they are today.

. . . The sweatshop is passing from our midst. The ocean liner's stokehole hell is but a memory. Men whose grandfathers slaved in shops unheated in winter and unventilated in summer, are working in plants where comfortable, healthful working conditions are taken as a matter of course. Aroused public sentiment played a part in bringing these changes about; advanced scientific knowledge did its share. These factors undoubtedly helped; but *what actually revolutionized our standards with respect to working conditions was the growing knowledge that the old way did not pay.*

. . . A poorly ventilated or inefficiently heated industrial plant today is not merely "behind the times"; it is actually operating under a severe handicap. Accident records, spoilage, production ratios, plant morale—these are the things that take their toll out of profits, where working conditions are neglected. The plea that a plant "cannot afford" modern standards of heating and ventilation is swept aside in the realization that these standards have been brought about so surely and inexorably because they have proved a dividend-paying investment.



A steel mill encased in glass with windows that open. Note the unique "M"-shape roof.

Heating and Ventilating Practices *at the Ford Plants*

By FAY LEONE FAUROTE

New York City

Co-author with H. L. Arnold of Ford Methods and the Ford Shops

IT HAS been calculated by experts that man working under ideal conditions develops about one-seventh of a horsepower; that in order to produce one kilogrammeter of work eight small calories are expended. In other words, he has an efficiency of about 30 per cent. The human machine can develop, on the average, 300,000 kilogrammeters of work per day. A good steam engine would require about one kilogram of fuel to do the same work, about double the consumption of the human engine. Man is, therefore, a valuable machine when considered from a purely mechanical standpoint. The fact that he can think for himself, is capable of self-repair, has an extremely long life when compared with other mechanisms producing the same amount of products, makes the study of man-power especially interesting and worthy of continuous observation and experiment.

INJURIOUS GASES are led off through hoods and ventilating ducts where brazing or soldering operations are performed.

Whether one is doing mental or physical work there is a constant expenditure of energy and it has been found that certain external conditions seem to have a marked effect upon both efficiency and the quality of output. Food, air and water, so-called environment, have great effects upon the rate and continuity of work. Temperature, too, is a governing factor; as is humidity. To do the best work external conditions must be made as comfortable as possible and scientific research has set limits, minimum and maximum, beyond which the wise manufacturer will not go. Purely apart from sentimental or so-called humane reasons, proper heating and ventilating practice is therefore good business. And the directors of the vast industrial organizations

Roof ventilation such as this, combined with exhaust systems, keeps lower floors habitable.

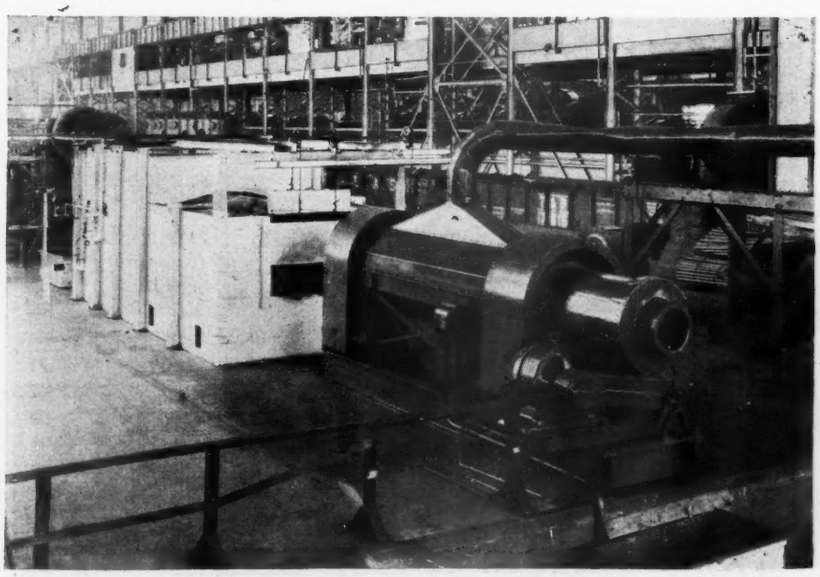
throughout the world rapidly are coming to see the obviousness of this truth.

Wholly apart from the food problem, which is a whole story in itself, the control of heating and ventilation in the Ford industries, whereby some 120,000 men are able to work at or near full efficiency without excessive fatigue, forms one of the most interesting stories of industrial engineering.

Air contains 78 per cent nitrogen, 21 per cent oxygen, by volume, with less than 1 per cent of argon. This is in its pure state. Where factory processes are in progress there may be more or less carbon monoxide, chlorine, sulphurous acid gas and other deleterious gases and dust particles of various kinds. Toxic gases, however, are of course detrimental and a good heating and ventilation system will eliminate them either by some form of neutralization or purification or by conducting them far enough up into the upper air so that they will not affect the workmen nor those living in the immediate vicinity of the plant.

The matter of odors arising from certain processes is likewise a very important one and must be dealt with vigorously. The elimination of stack gases, of smoke, cyanide fumes, lead fumes, vapors and fumes from lacquer, varnish and paint, blast furnace gases, coke ovens, steel mill operations, cupolas, distillation processes, paper making, artificial leather manufacture, glass manufacture, has presented to the Ford ventilation enginers problems which in complication and variety probably exceed that of any other single industry in America. Therefore it is thought that the readers of *Industrial Engineering* will be interested in a description of how Ford architects and engineers have attacked these problems and by what means external working conditions have been kept will within what are regarded as healthful and efficient limits.

In such a large plant as the 1,115 acre Fordson group almost every known kind of ventilation is in vogue, from a simple open window to the most improved type of forced or exhaust ventilation installation. It has been the practice of the Ford Motor Company always to specify buildings which shall have ample window space, both on the sides and in the roofs. They are generally made of brick, stone, glass and steel with now and then fine buildings of limestone and marble. The power plants, especially some of the hydro-electric ones, are models of industrial architecture. The great half million horsepower power plant at Fordson, which burns pulverized coal, is as spotless as a dairy, and despite the high temperatures inside the furnaces, the corridors are comfortable and airy. The generator room might well be the great exhibition hall of a mechanical museum.



VENTILATING DUCTS play a prominent part in removing the dust that is inevitable in grinding and other tumbling operations.

STEEL SUPPORT columns with an affinity for radiators. This is a view in the foundry tool room boring department.

The roofs of most of the large Ford buildings are based on a special type of ventilated monitor design which has the advantage of affording plenty of light and free ventilation. Alternate large and small M bays admit of the use of a concrete or tile covering on the top and several rows of windows on the sides. The theory is, and it has been pretty well established, that the air circulates freely when certain of the windows are open, and by shifting these openings almost any combination of air currents may be provided.

It is remarkable how well this simple system of ventilation operates. For example, I have been in the spring upset building in the month of August, have stood in front of a battery of electric furnaces which extends along along one side. There are 76 furnaces in the spring department, capable of handling 6,000 rear springs, 12,000 front springs for the Ford Model A and 2,500 springs for the truck in two eight hour shifts, as well as 28 forging furnaces and 11 others used on miscellaneous work, some of which operate up to 2,400 degrees F. By the simple expedient of opening certain ventilators it is possible to create a draft through this building which is almost the equivalent of an electric fan in effect. When the wind is in certain directions it is even necessary to close ventilators to prevent excessive circulation. On the other hand, I have noticed that in the months of January and February

OPERATORS in heat treating and babbitting departments are thoroughly protected from fumes with ventilating devices as shown above.

* * * *

TEMPERATURES in this room containing 115 furnaces are kept at a comfortable point by means of proper roof ventilation.

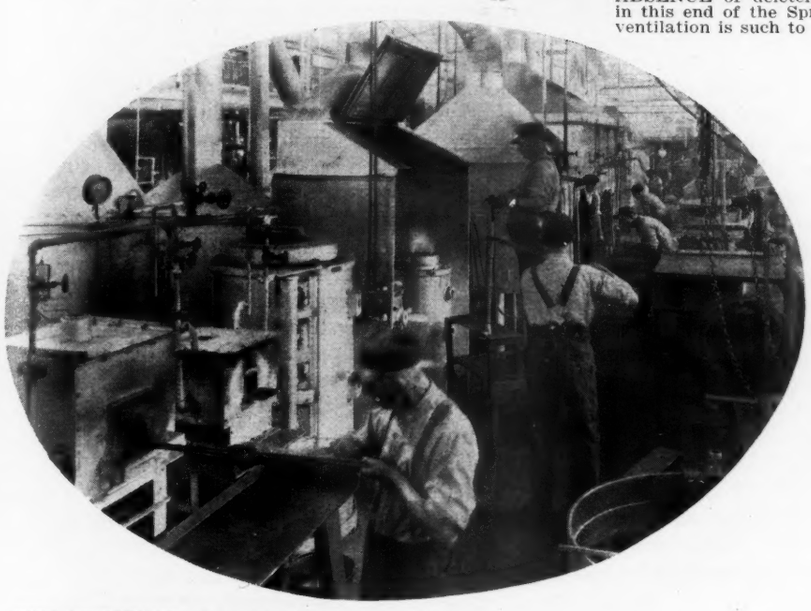
one can walk through this shop in his shirt sleeves in comfort.

Contrasted with this condition, however, there are certain places such as the glass plant, for example, where a wholesale violent ventilation cannot be allowed. In such a building there are bound to be some hot spots where men must work in high temperatures because the process allows no alternative. Here conditions are mitigated by shooting a direct blast of cool air into the region directly surrounding the workmen. As a case in point, the man who stands at the head of the lehr, at the point where molten glass comes out of the furnace in its white hot plastic condition, is cooled by an individual blast which effectively in-

sulates him from the surrounding atmosphere. Thus, conditions under which he has to work are very little different from those of the man serving a heat treat furnace or working at a forge.

The high vaulted ceilings of the steel mill, the spring and upset building, the pressed steel building and others of this type create a condition which simulates, to a remarkable extent, conditions in the open air of spring or summer. Wherever there is a cyanide furnace, a babbitt melting pot, a lacquering oven, a gas preheating furnace, there are of course ducts or chimneys with natural or forced draft to carry off these deleterious gases. In many cases, heat is conserved by carrying the hot gases

ABSENCE of deleterous gases and smoke is evident in this end of the Spring and Upset building. Natural ventilation is such to rapidly clear the room.



THE PRESENCE of ventilating ducts does not imply that all gases are wasted. Conservation is practiced by carrying hot gases to other processes.

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to another process and making them do double duty before they are discharged into the upper air. This is the case at the Iron Mountain plant where the stack gases are used in the charcoal and distillation processes conducted in another building.

Dust collectors of all kinds and exhaust systems are scattered throughout the wood working departments; hoods and covers surround grinding operations; in the plating rooms the tanks are covered with hoods or set in special rooms from which the air is constantly exhausted. In the foundry powerful exhaust systems carry the dust out and above the roof line or into a depository where it is sometimes reclaimed and reused.

Where heat treatment furnaces are located and gas is used for fuel, ducts and chimneys carry off the products of combustion, special heat shields over the openings and great open doors in the side of the shop make free ventilation natural and ample. This is also true of the drop forge shop. The fact that many of the japanning and lacquering operations are performed while the parts are passing through corridors on conveyors allows such fumes to be led out and up into the upper air without contaminating the immediate atmosphere of the shop.

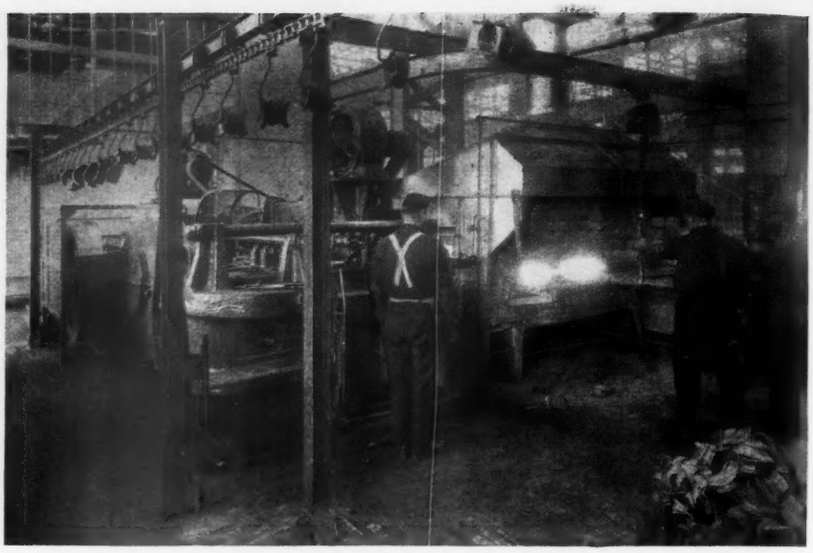
In some of the buildings the interior of the columns is utilized for a combination heating and ventilation duct, the air being forced up and out

IN THIS ROOM, 76 electric furnaces are in continual operation. This photograph was taken during a normal working period.

through grills set in the outside shell of the columns. The electric lines and heating coils are usually carried along the walls or above, under the roof trusses, well out of the way of machinery interference. Heating is by steam, wherever it is possible to bleed low pressure steam from turbines or other steam engines. In some of the newer and larger buildings, however, hot water heat has been provided.

In none of the buildings is there a general or standardized system of air conditioning; special cases being taken care of as required. All the systems for the removal of fumes have been installed by the Ford Motor Company engineers to meet particular requirements. In all instances where there are fumes and smoke an exhaust system has been installed, the ducts carrying the fumes and smoke out and up, discharging above the roof surfaces. The tumblers and shake-outs are all connected to dust collector systems that discharge in this way. In the grinding department all of the residue is reclaimed, cleaned and eventually reused.

In the spring and upset building, glass plant, parts of the steel mill, and in the motors building the heating is by forced circulation hot water systems with radiators under the windows in the outside walls and long pipe coils to the trusses overhead. The systems are unique inasmuch as they do away with mains to a great extent, using only the coils for conducting the hot water from the cross mains, which are usually located at the center of the building.



ENCLOSING HOODS about the top of gas furnaces used in preheating operations carry away the products of combustion.

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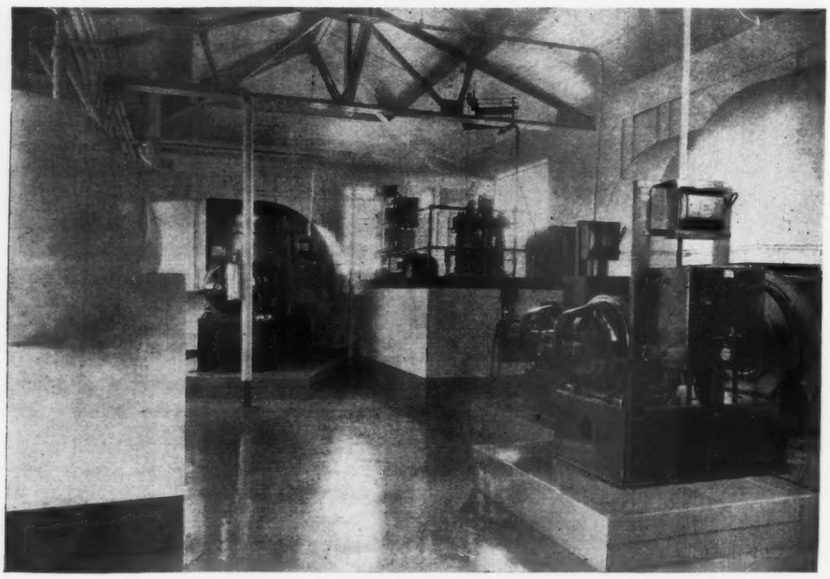
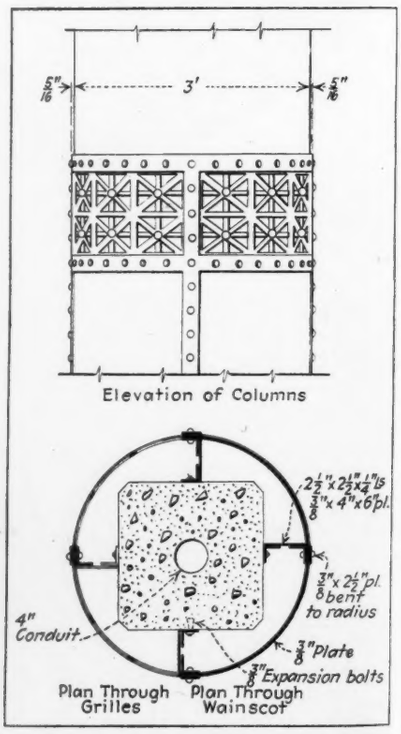
The new administration building at Fordson is heated by means of a system of forced circulation hot water with heaters and pumps in the basement machine room. Direct radiators on this system are located in all offices under the windows and in the important rooms these radiators are concealed. The Administration building is provided with a supply system for furnishing fresh air to the inside offices adjoining the corridors. The air is exhausted from the corridors and the circulation between the supply and exhaust registers is maintained by means of grills in the bottom panels of the corridor doors.

The engineering laboratory building at Dearborn is heated by means of large supply fans delivering warm air through the building through hollow spaces in the columns with grills located in the faces of the columns approximately eight feet above the floor level. These fans can also be used in the summer time for delivering air to the building for ventilation. However, this is not primarily a cooling system, since no refrigeration has been provided. Direct radiators are installed along the outside walls underneath the windows.



WHAT the interior of a pent house at the Ford plant looks like with its complement of ventilation machinery.



COLUMNS are used for other purposes besides holding up ceilings and being ornamental. Plan and elevation sketches show the details of the construction.

Taking the guesswork out of

MAINTENANCE SCHEDULING

By R. W. DRAKE

Plant Superintendent, International Harvester Company, Chicago, Ill.

"HARRY, when did we overhaul the big river tie line switch last?"

"Why, I don't remember exactly, but Charlie will know. I always keep Charlie overtime on that sort of a job."

"Charlie, when did we overhaul the big river tie line switches last?"

"I don't remember—Oh, yes, it was in the spring for I had tickets for the first ball game of the season, and you made me work."

"But, Charlie, was it this spring or last spring?"

"I'm sure I don't remember."

"Harry, I guess there is nothing for it but get into those two switches Saturday afternoon. You remember when we let it go too long the year you came here. The switches heated up and you found the stationary arcing contacts burned clear through and the main bridges burned so badly that we had to put in new ones. We can't take a chance. We might be forced to reduce the load on that line in the middle of the week."

Harry held two electricians and a helper for each big switch. A special crew was necessary to operate one power plant ordinarily shut down on Saturday afternoons, and considerable extra coal was burned. Both switches were found in fine condition, would have run three times as long before an overhaul became necessary. Total cost, labor and coal, $75.

A competent plant engineer familiar with his plant by never ending thought of such details is able to make such occurrences uncommon. Unless he has reduced the matter to some such system as I am about to describe, the plant engineer of a large plant will admit, if he is honest with himself, that:—

(1) He spends an enormous amount of mental effort in keeping such jobs in mind in order not to allow them to go too long. This time and mental effort if expended on something else would be of real value to his employers.

THE DETAILS of making and operating a tickler system need follow no ironclad rules. For the man who has no such system at all, this description of a successful system, as modified through ten years use, will be helpful. For the many men who are already operating a similar system, many of the "kinks" developed to meet special needs, will be of interest.

(2) He "opens for inspection" much equipment which could just as well be inspected at much less frequent intervals, but he does not know how much longer intervals are safe.

(3) He not infrequently guesses too long on the interval between inspection and overhaul, thus greatly increasing the cost of the necessary repairs, and occasionally causing a manufacturing delay.

(4) In case of his prolonged illness or if he left his present position, all of the above difficulties would be greatly accentuated for several years. He may be training a subordinate who would know what to do and how to do it but it is certainly an exception if this man would know when to do each of several hundred such jobs next and how frequent to do them thereafter. His only chance to avoid disaster would be to play safe, do all such jobs too often until he could develop his judgment.

Many plant engineers have relieved their minds of this load of detail by some such application of a "tickler" system as that which follows. These men will be interested in some of the "kinks" which someone else has developed in this connection. Many others will be surprised to realize that they can greatly reduce the frequency of inspection of much apparatus, and still decrease the manufacturing delays arising therefrom by such a means.

There are two reasons why many men fail to start such a system:

(1) Foremost, it takes considerable labor to make a start.

(2) The system does not reach its greatest usefulness until it has been in operation two or three years.

To the first, I can say, if you cannot find the time to put all such jobs "on tickler" take care of the jobs which come up infrequently first. There are not so many of them, it is harder to keep them in mind and do them when they need to be done, and there is more saving of wasted labor on these jobs. Take a job which really needs doing once in two or three years. Who keeps such an accurate mental record of all such jobs that he does them at about the proper intervals? More likely he does them each year or oftener. Once a start is made, it is easy to add additional jobs a few at a time.

To the second objection, I can only say this. The first guess as to how long any given equipment can run between overhauls is no better and no worse for being recorded, rather

Mr.

REPORT ON PERIODICAL INSPECTION OF ELECTRICAL APPARATUS

Frequency of Inspection (18) 12 Months

Description Westinghouse Oil Circuit Breaker #399924 River Tie Line

Instructions Inspect contacts, wooden rods, and check bridge pressure. Replace moving and stationary arcing contacts. 12

Date of Next Inspection	REMARKS	Insp. Compl.
11/19/16	Stationary arcing contacts burned entirely through. Main contacts burned. Had run too long.	
7/21/17	Could have run longer	
8/1/18	Put on 5 new stationary arcing contacts. Ran just about long enough	8/17/18
8/1/19	Put on 2 new " " "	8/22/19
8/1/20	Switch very little used. Currents interrupted abnormally light. Safe to delay inspections 6 or 8 months.	8/4/20
2/1/21	Put on all new arcing contacts.	8/29/21
8/11/21	Opened up ahead of time because bus was dead. Overhaul another switch. Putting 2 upper and 5 lower contacts	8/11/21
8/1/22	Put in 3 stationary contacts and 5 tips. Would have run another 6 months safely. Try it at 12 months once more before increasing time.	8/13/22
8/1/23	Put in 5 arcing contacts and 8 Tips.	8/9/23
2/1/25	Put in 5 arcing contacts, one spring sour. Stationary contacts burned through. Timer too long. I think 12 months.	2/19/25

FIG. 1—TYPICAL REPORT OF INSPECTION; in this case, of an oil circuit breaker. The original card is 7½x10 in. in size, allowing ample space for the necessary entries, without cramping.

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than carried in someone's head. It is true that a tickler begins to be authoritative in determining the proper frequency for doing such jobs only after it contains the record of two or three inspections, with the conditions found at each inspection. The relief from the mental burden of remembering to do the job is, however, immediate.

The details of making and operating such a tickler need follow no iron-clad rules. For the man who has no such system at all, a description of a successful system as modified through ten years' use will be helpful. For the many men who are already operating such a system, many of the "kinks" developed to meet special needs in ours will be of interest.

We have not found it best to include in the plant engineer's tickler jobs which are done more often than once per month. When one foreman or operating engineer is responsible for a considerable volume of routine maintenance work which is done more often than once per month he can build a tickler system for each day of the month which can be so planned that it saves him much of the labor of assigning work to his subordinates.

For each job on the plant engineer's tickler, there is an instruction card in duplicate.

On the first of each month each foreman in charge of a maintenance gang receives cards for the jobs which come up during that month. He may plan to do them at any time during that month. Under ordinary circumstances it is expected that all these cards will be returned by the first of the following month.

The larger these cards, the better, up to letter size.

When a card is sent out to a foreman, the duplicate or office copy is turned up on end in the file in the office. The cards on end in all months previous to the current month, show jobs which should be finished and have not been so reported.

When a job comes back from a foreman, a clerk or a stenographer copies the foreman's notes or report on the duplicate. This labor of keeping an up to date duplicate of every card may seem wasted. It is not.

(1) If a card were lost, except for the duplicate, the job would be in many cases forgotten until a breakdown occurred. The tickler works so well that the plant engineer and foreman no longer continually worry about whether such jobs need doing or not. Furthermore, all the records of the past inspections on which to base an intelligent estimate of the necessary period between inspections would be lost as well.

(2) There is no temptation for a foreman to permanently "lose" a card for a job which he has forgotten to do within the specified time, or for a very nasty, dirty job which he dreads to do.

(3) If a foreman mislays a card, the check-up of office duplicate on end in the office file will remind him at the end of the month.

(4) The information on these cards is not infrequently referred to

in the office for other purposes. It is an advantage to have a copy of every card on file at all times.

We carry our tickler five years ahead by months. There are many jobs with periods of two and three years, and some with longer periods.

This system is not so arbitrary as to be inelastic. For example:—A foreman notices symptoms which lead him to believe an inspection is needed. He is instructed to inspect, repair completely and report date, repairs made and condition. This interim irregular inspection is entered on the card by the office clerk or perhaps by the plant engineer himself. If the conditions found warrant it the period between inspections is decreased. At any rate the time for the next inspection is set forward and the cards for this job set forward in the file.

Similarly, some jobs require comparatively little time, and inexpensive materials. The special switching and special power house operation on Saturday afternoon or Sunday necessary to take the equipment out of service for inspection or overhaul is the expensive part of the job. Now if this special operating set up is required for some other reason, a foreman may obtain authorization to do the job ahead of time, telephone authorization perhaps. He is instructed to replace worn parts, even if less than half worn out, so that the time for next inspection may be set ahead a normal period. The card will be "dug" out of the file and mailed to him for this irregular period inspection.

How do we determine the period between inspections? The card shown here covers a very simple job which was selected because it will illustrate several points concerning the system without requiring any considerable explanation of the job itself.

It will be noted that this job was put in the tickler late in 1916 after an overload when expensive repairs were required, because the job had been allowed to go too long. A set of bridges and stationary contacts for this switch cost close to $500 and a full set were required. If the switch had been overhauled in time, the cost of the stationary and moving arcing contacts required would have been less than $10.

The next inspection was made in eight months. There is no record of the repairs required, but the foreman reported, "could have been longer." A period of twelve months was then set. The 1918 report indicated that this period was about right. The 1919 report confirmed this opinion. In 1920 the plant was slack. When the card came up, the plant engineer felt sure that the duty on the switch had been so light that it was safe to put off this job for eight months. Accordingly he set the card ahead in the file to come up eight months later. In August, 1921, the switch was opened up ahead of time, because the bus was killed for another repair. In August, 1922, the condition of the switch led the foreman to report that he thought it safe and advisable to increase the period of inspection to eighteen months. The plant engineer's decision was to wait another year and see if this was a "fluke." The report of the inspection a year later led him to the opinion that the foreman was right. Accordingly the frequency of inspection was increased. The next inspection eighteen months later proved them both wrong. Conditions were not bad enough to have caused a shutdown, but matters had progressed so far that renewal of cheap easily replaceable wearing parts was not sufficient and $270 worth of repair parts was required. The period of inspection was placed at twelve months once more. With such a record on a card, a foreman's suggestion to increase the inspection period to eighteen months, at any time in the future, would receive but scant consideration. The plant engineer would talk over the past entries with the foreman, amplifying the recorded notes, if the foreman were a newcomer, unfamiliar with the previous circumstances. Then, unless convinced of a decided change toward less severe operating conditions, he would leave the period unchanged.

THE FIRST guess as to how long any given equipment can run between overhauls is no better and no worse for being recorded rather than carried in someone's head. It is true that a tickler system begins to be authoritative in determining the proper frequency for doing such jobs, only after it carries the record of two or three inspections, with the conditions found at each inspection. But the relief from the mental burden of remembering to do the jobs, is immediate.

The greatest difficulty in starting such a system is the matter of educating the foreman out of pennywise policy. We find it safest to determine as closely as we can the longest period that the apparatus will run without break-down and without necessitating repairs, other than the normal replacement of parts which we desire to consider "expendable." We then set a period of about two-thirds this length, as the inspection or overhaul period. Where duty is variable or the normal life of parts irregular, sometimes an inspection period of one-half or even less of average estimated maximum life is necessary.

All routine maintenance jobs do not lend themselves to exactly this procedure. There are jobs where the value of the material far exceeds the value of the necessary labor. In such cases special methods of recording service to obtain nearer to maximum service are warranted.

A simple case is two heat treating furnaces containing a number of thermocouples and protective tubes. The cost of a protecting tube is about five times the replacement labor. About two years observation with monthly inspection of tubes operating at different temperatures determined the life of tubes in hours of operation, but, the furnaces are operated irregularly, one being shut down for refractory repairs for weeks at a time, and elapsed months and months of service are by no means the same. Had the cost of a protecting tube been less than a dollar, it would be close enough to assume that both furnaces run every day and replace tubes regularly on that basis. This we do with the thermocouples. The protecting tubes cost roughly $10 each; there are four or five in each furnace. There is attached to the card an envelope containing a booklet ruled for a simple tabulation. This record "comes up" every month. A chaser interviews the department foreman operating the furnaces and obtains a statement as to how many weeks each furnace operated during the month. These figures are added to the previous weeks of service for each tube. When the total for any tube equals the red ink figure at the top of the column in the tabulation, the tube is replaced. It is unreasonable to replace all the tubes in a furnace at the same time, for the operating temperatures are different and the lives therefore differ widely.

The tickler system is used for jobs from the most important to the most humble. One very simple thing used to cause considerable expense occa-

sionally. Each potentiometer type pyrometer contains a dry cell which lasts a few months. When the dry cell is exhausted, the pyrometer cannot be "balanced." The foreman at the heat treat department called the electrical headquarters of his division at the works and the cell was replaced promptly. Sounds all right, doesn't it? But these cells had a way of expiring on night shift. At night there is only one electrician on duty in a division and he is not always near his phone. Every time that the electrician could not be located, the furnace man was obliged to hold temperatures by eye. The result was, of course, inferior product or scrap. The weather around the inspection department the next morning was likely to be stormy.

Now when the card comes round every so many weeks, a man takes the card and an armful of dry cells and installs a new cell in every pyrometer whose location is listed on the back of the card. We cannot get full life from the cells, but they are cheap, and there is no more spoiled product from the cause.

For some jobs the card reminds us at the proper time to make inspection, but it is necessary for a foreman or in other cases junior engineer from the office to go out a time or two with any new man to show him how. This works well enough for frequent jobs, but a man will forget the details of jobs which recur only once in thirty months. The ideal method in such cases is to work up typewritten instructions and diagrams or drawings, so clear, and in such detail, that any man of intelligence and training fit for the job can complete the job without an old hand, who may have forgotten some of the details, to work with him two or three times. Such jobs are the routine adjustment of spring tensions on a Tirrel regulator, routine inspection of control and alarm system for semi-automatic "operatorless" substations, and calibration or check of various sorts of relays.

The composition and compilation of such instructions has been carried out on a broad plan by some larger maintenance organizations, notably the Philadelphia Electric Co. It is well worth while, but not every engineer capable of doing the work acceptably has that "knack" of realizing beforehand the mistakes which the young electrical maintenance man or "chaser" or junior engineer will make, and making his instructions and explanations so lucid and so complete that a uniformly acceptable job will be the result. The men who have this gift rapidly gravitate to the top of the organization, for the same mental qualifications make them successful at engineering studies and engineering reports which obtain the desired appropriations. They soon become too busy (or, as some of our maintenance men believe, too lazy) to write maintenance instructions. To write detailed instructions to go with each of our several hundred cards would take two or three years of a good man's time. It would be well worth while from the standpoint of labor saving alone, not to speak of the advantage in case of another war or something which would break up our organization.

ONE MAN, out of a mass of seemingly irrelevant and inconsequential notes, recorded through several years, has solved valuable explanations and remedies for troubles which had been chronic vexations. He also brought forth the discovery that transformer "breathers" collect almost no moisture in winter; i. e., they should be inspected monthly in summer, but not at all in winter, in some locations.

With the great majority of equipment if inspection and overhaul is carried out at the desired frequency, the cost of labor is far greater than the cost of the necessary material and repair parts. Such conversations as the following were very common for the first few years, particularly with the older foremen, who had been brought up in a more economical(?) way of thinking. Some men required five years to develop their "dollar judgment."

"I was coming over to straighten out with the time-keeper about a shortage in one of my men's pay, and I thought I had better bring this card in myself instead of mailing it in; I want to tell you about it."

"Well, George, what is the matter, do you think we are letting it go too long?"

"Oh, no, but those contacts will last a while longer. I only changed two and left the rest in. I just wanted to explain to you and ask you to send that card out again to me in about three months instead of a year as the card indicates."

"George, how much do you think those contacts cost?" George doesn't know. He has no way of knowing. That is one of the weaknesses of a big organization. None of the foremen know enough about the net prices of the material they handle.

Then follows a long painstaking explanation to try to show George that he is attempting to salvage 30 per cent or less of the life on twelve repair parts costing 35c. each, the total salvage value being about $1.25; and to do it he is expending three hours time for an electrician and his helper, and operating an engine room overtime on coal in order to work on his equipment dead, while the usual method of operation would burn wood waste costing nothing. Finally, we come to the point where George sees the light. George sighs and says, "Well, it does certainly seem a waste to change all those contacts three months before they were worn out just so you won't have to open up the switch for another year, but it is certainly easier for me if you want it that way." Of course, such difficulties could be eliminated by listing on each job card the parts to be replaced.

The difficulty of the man who simply cannot confine his report of a simple matter to a line or two on a card troubles us no more. We have some little blank books about the size of the card and send them along. Let him write to his heart's content. Incidentally some of these "windy guys" as our clerk calls them (he must copy their effusions on the office duplicate) are not so insane as at first appears. One man, out of a mass of seemingly irrelevant and inconsequential notes, recorded through several years has several times evolved a valuable explanation and remedy for an old trouble which has vexed us for years, and frequently made valuable inspection suggestions, such as his discovery that transformer "breathers" collect almost no moisture in winter; i.e., should be inspected monthly in summer in some locations, but not at all in winter. Blank books are cheap. Let them write.

How does the idea impress them when they get used to it? My best answer to that is an experience of my own. In war time, when I planned to enter the service, foreman after foreman asked me privately to give him the cards pertaining to his work, saying, "The new chief might not continue the system and it is so much easier to keep things going this way, and so much less grief at that."

Control connections such as these indicated are used in electric braking combinations.

Stop That Waste!

How ELECTRIC BRAKING is applied to convert energy that is usually wasted into useful power. A discussion of the three classes of electric braking.

By J. A. JACKSON

Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

ONE of the valuable characteristics of nearly all the more commonly used electric motors is that they are equally capable of converting electrical energy into mechanical energy or mechanical energy into electrical energy. When used in the latter way electric braking is said to take place.

The characteristics of some motors are such that the change from one condition to the other is brought about by a small change in speed—usually less than 10 per cent. With other types, electric braking can be brought about only by a change in the control connections, and in any case where electric braking is required to act through a wide range in speed with overhauling loads, a change in the control connections is necessary. Direct-current motors lend themselves more readily to accurate speed control during electric braking than do alternating-current motors.

From an electrical point of view, electric braking falls into three classes: (1) Regenerative braking, (2) dynamic braking and, (3) back-torque braking, commonly known as plugging. Some control connections give a combination of the first two classes.

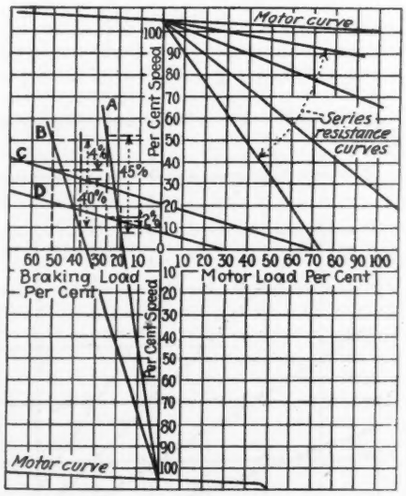


FIG. 2—SPEED CURVES of d.c. shunt motor with back-torque braking and dynamic braking. Curves *A* and *B* show that with back-torque braking, or plugging, a small change in load results in a comparatively large change in speed. With dynamic braking, curves *C* and *D* show that speed regulation is much better, as a large change in load results in a small speed change.

* * * *

The only motors that will be considered in this article are a.c. squirrel-cage and wound-rotor induction motors, and shunt, compound and series d.c. motors; other types of motors are seldom used on applications where electric braking is necessary.

It may be well to explain here the difference between the three kinds of braking. Regenerative braking occurs when a motor being driven by an overhauling load reverses its armature current and delivers all the reversed current back into the supply.

Dynamic braking occurs when a motor being driven by an overhauling load reverses its armature current and delivers all the reversed power to a resistor, whence it is dissipated in heat.

Back-torque braking or plugging occurs when the connections to a motor being driven by an overhauling load are reversed through a suitable protective resistance, under which conditions the motor attempts to deliver power to the system by boosting the voltage. The excess current is absorbed in the protective resistance and dissipated as heat.

Regenerative braking thus saves the energy converted on stopping, whereas dynamic and back-torque braking waste this energy. Such waste, however, is justified by the results obtained.

Dynamic braking and plugging can both be used successfully for retarding loads, each having slight advantages in certain applications. They cannot be used with equal success, however, for speed regulation with overhauling loads, as an inspection of Fig. 2 will show that plugging curves *A* and *B* give very poor speed regulation, whereas dynamic braking curves *C* and *D* give very good speed regulation. For example, with a load change from 18 to 25 per cent, curve *A* gives a speed change of 45 per cent whereas curve *D* gives a speed change of 2 per cent. Curves *B* and *C* also show the same characteristics respectively; hence, where loads are to be handled at reduced, steady speeds, dynamic braking is much superior.

The accompanying tabulation on page 445 shows which kinds of braking can be used with each type of the commonly used d.c. and a.c. motors.

Any application on which the load may, in regular operation or under emergency conditions, overhaul or tend to overhaul the motor while running at any speed, can utilize electric braking. Examples of such applications are the hoist motions on cranes and coal or ore bridges, skip hoists, car dumpers, retarding conveyors, elevators, slope hoists, mine hoists, and so on.

Other applications where electric braking may be used effectively are those on which there are no overhauling loads in the true sense, but where inertia loads must be slowed down more or less rapidly and under full control. Such applications include electrically-propelled cars of various kinds; the trolley and bridge motions of cranes and bridges; certain machine tools, such as reversing planers; revolving motions of jib cranes, excavators and shovels; and practically all applications referred to under the preceding heading.

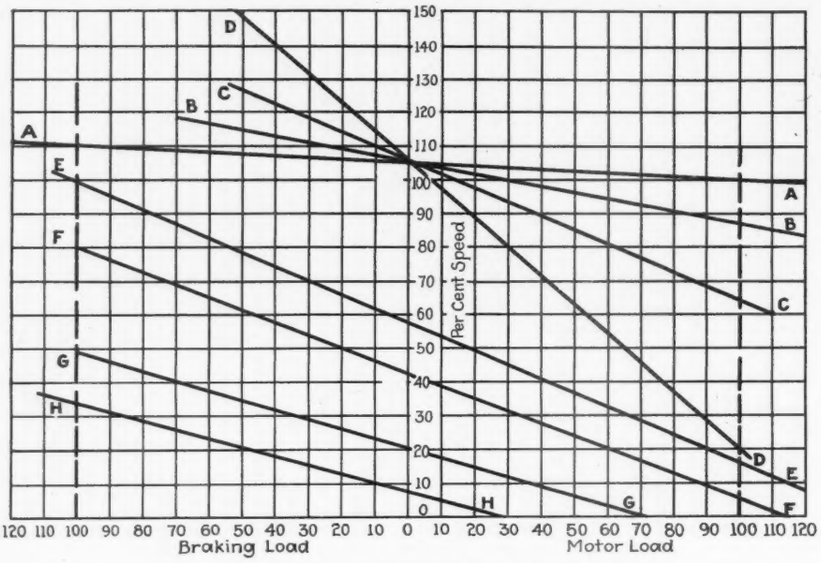


FIG. 3—SPEED-LOAD CURVES of a d.c. shunt motor with and without resistance in series with the armature. Curve A represents the normal speed-load conditions, and curves B, C and D show the performance with different values of resistance in the armature circuit. Curves E, F, F, and H show the result of putting different values of resistance in both in series and in parallel with the armature, and indicate that overhauling loads can be handled at safe speeds with dynamic braking.

* * * *

Electric braking is, therefore, not uncommon but finds a very wide application. Its use undoubtedly saves many thousands of dollars yearly in wear and tear on mechanical brakes and in power returned to electric supply systems.

A d.c. shunt motor has a nearly flat speed-load curve. The speed usually does not drop off more than 5 per cent between no load and full load. If this speed-load curve (Fig. 3) is projected back of zero load as shown on curve *A*, it shows what happens when the load becomes overhauling and tends to drive the motor. If the overhauling load goes to 100 per cent, the speed has increased only 10 per cent over the full-load motoring speed; this change in electrical condition takes place automatically, with no knowledge or effort on the part of the operator.

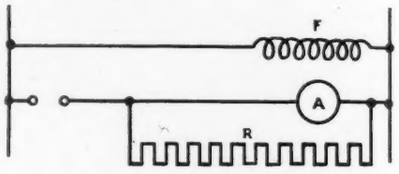


FIG. 4—FOR SOME applications of dynamic braking a resistance is connected across the armature of a shunt motor. This arrangement gives the speed-load curves shown in Fig. 5.

* * * *

This motor is, then suitable for such applications as elevators, skip hoists, car dumpers, retarding conveyors or on any application where reasonably constant speed is required under all load conditions and, in some

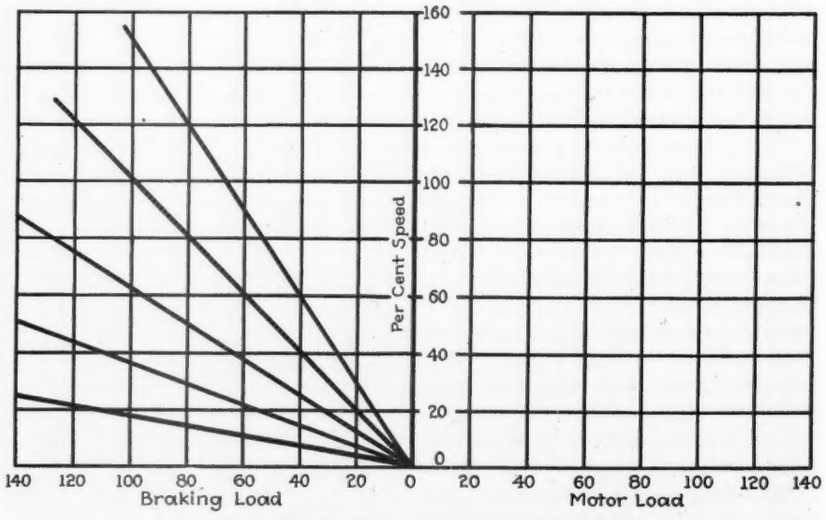


FIG. 5—THESE LOAD-SPEED curves represent the performance of a shunt motor with different values of resistance connected across the armature.

* * * *

Braking Applications for Which Different Types of Motor Are Suited

1. Regenerative braking. 2. Dynamic Braking. 3. Back-torque braking.

Motor	Well Adapted for	Poorly Adapted for	Cannot Be Used With
D. C. shunt	1, 2, 3	----	----
D. C. series	2, 3	----	1*
D. C. compound	2, 3	1	----
A. C. sq. cage	1	3	2
A. C. slipring	1, 3	2	----

* Series motors can be used to give regenerative braking when the control connections are changed to connect them as shunt motors.

cases, in each direction of rotation.

Now, if some resistance be put in series with the armature of a shunt motor slower speeds are obtained with motor loads, but higher speeds are obtained with overhauling loads. Curves *B, C* and *D* in Fig. 3 represent three different amounts of resistance in the armature circuit; it will be seen that as the resistance increases the speed becomes higher for any given overhauling load.

For example, on curve *D* (the highest resistance) the speed at 50 per cent overhauling torque is 148 per cent, as against 107.5 per cent on curve *A*. Where higher overhauling speeds are desired this may be advantageous, but where over-speed is a detriment, as on elevators, the control must be so arranged that the operator cannot run the machine with series armature resistance in circuit.

On many applications using shunt motors, some slow-speed regulation is required under either overhauling or motoring loads, and the operator does not always know which kind of load he has. This condition can be taken care of safely by providing control points that connect some resistance in series with the armature and some in parallel with it. By varying the values of these two resistances, speed-load curves such as shown at *E, F, G* and *H* in Fig. 3 can be obtained, from which it is seen that overhauling loads can be retarded by electric braking and run at safe, slow speeds.

For example, a 50 per cent overhauling load may be handled at 107.5, 78, 61, 35 or 20.5 per cent speed, as in curves *A, E, F, G* and *H*, respectively. With the values of resistance generally used with this series-parallel connection, the braking is all dynamic, although it would be possible with unusual values of resistance and load to get a combination of dynamic and regenerative braking.

Occasionally an application arises that requires the connections shown in Fig. 4, where the motor armature is cut off from the line and a resistor connected across it. This arrangement gives the load-speed curves shown in Fig. 5, each curve being obtained by using a different value of resistance. This is solely dynamic braking and no motor torque can be produced. The overhauling load must, therefore, be able to break static friction and start the armature turning.

A d.c. shunt motor is well adapted for back-torque braking, and on reversing applications requiring a quick stop, this kind of braking or plugging gives very satisfactory results with the simplest control. It is, however, not quite so reliable as dynamic braking, for, should power fail just prior to or during retardation, no braking effect can be obtained by back torque, whereas dynamic braking will give some degree of retarding due to the slow decay of the field flux.

A d.c. series motor connected as such cannot regenerate, as regeneration can occur only when the field current keeps flowing in the same direction while the armature current reverses. This is a condition impossible in a series motor.

On the other hand, a series motor is much more flexible than a shunt motor for obtaining dynamic braking and is equally as good for back-torque braking. This flexibility results from the possibility of arranging the connections so that the series field may be either inside or outside the dynamic braking loop circuit, as in Figs. 6 and 7. When inside, as

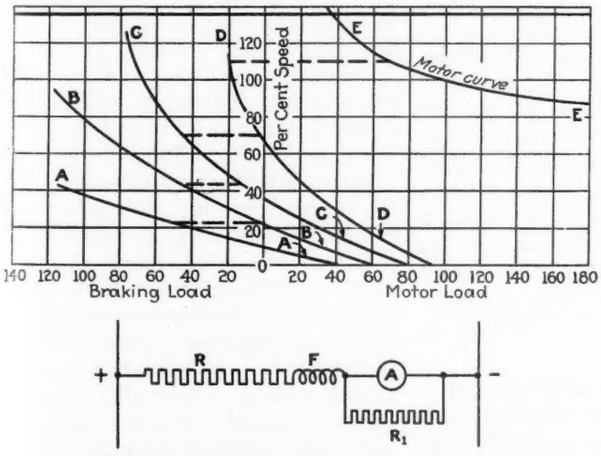


FIG. 6—WHEN THE FIELD of a series motor is outside of the dynamic braking loop the performance is as shown here. The braking end of the curves shows a relatively large change in speed with changes in load, indicating lack of stability.

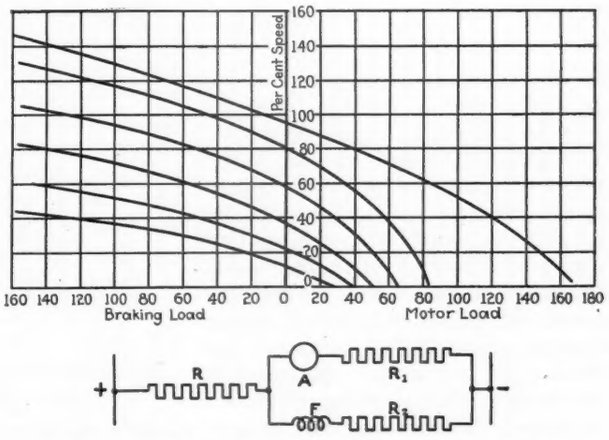


FIG. 7—HERE THE FIELD of the series motor is inside the dynamic braking loop. Owing to the stability of operation obtained with this arrangement it is the basis of all dynamic braking connections for series motors on hoists.

* * * *

in Fig. 7, the dynamic braking current adds to the field current and stabilizes the speed, making a very safe connection for lowering heavy loads. If the line connection should fail by the opening of an overload trip, or from any other cause, dynamic braking would be maintained with very little change, due to the braking current flowing through the series field. The arrangement in Fig. 7 is, therefore, the basis of all dynamic braking connections used with series motors on hoists.

When the field is outside the dynamic braking loop, as in Fig. 6, the braking part of the speed-load curve becomes unstable, due to the weakening of the field as the overhauling load increases. This may cause a runaway condition, thus making this connection unsafe for a hoisting load. It is useful, however, where stable slow speeds are required with motoring loads, as an inspection of the curves in Fig. 6 shows only small speed changes for large load changes on the motor load end of the curves.

For example, on curve *B*, the speed changes only 7 per cent with a load change ranging from 20 to 40 per cent. On the braking end of the curve, however, the change in speed is much greater for the same load change, thus showing a tendency to instability.

Connection Limits for Dynamic Braking

This connection is also useful for retarding inertia loads where the dead load is not an overhauling load. For example, when running at 68 per cent motor load, a braking torque of 20 per cent can be obtained by moving the controller to the position represented by curve *D*. This starts to retard the load. If at 70 per cent speed the controller is moved to the position represented by curve *C*, the braking torque is again increased to 46 per cent, thus speeding up the retardation. This process can be continued for curves *B* and *A*.

This connection is frequently used on the bridge motion of cranes and ore bridges to obtain a combination of creeping speeds and positive retardation. The connection shown in Fig. 6 gives dynamic braking only, as a regenerative current would reverse the field, thus causing a runaway condition.

The connection shown in Fig. 7 usually gives dynamic braking only, but may under certain conditions give both dynamic and regenerative braking simultaneously. A reversal of current through *R* to the line does not reverse the field current and consequently, no dangerous speed condition can occur.

Back-torque braking curves with a series motor are very similar to the same curves for a shunt motor, except that the speed is slightly more stable. Back torque is largely used for retarding the bridge and trolley motions of cranes and bridges, rotating motion on cranes, larry cars, and the like. It is not quite so safe as dynamic braking, as a failure of power stops the braking effect. On the other hand, with suitable connections, dynamic braking can be retained when power fails, as the braking current passing through the series field keeps the motor excited.

Safe Braking and Motor Selection

Compound-wound motors can be used safely with dynamic and back-torque braking, but they cannot be depended on to give regenerative braking with safety particularly if they have a heavy series field.

Although back torque can be obtained on a squirrel-cage motor, this kind of braking is not entirely satisfactory on account of the very high currents needed to produce the necessary torque; consequently, these motors are seldom used in this way.

Slip-ring induction motors give very satisfactory regenerative braking at about normal speed and on higher speeds although, like the shunt motor, the higher speeds that are obtained with secondary resistance in circuit become unstable as the speed increases. Curves *A, B, C* and *D* in Fig. 3 would apply equally well to a slip-ring motor. Unfortunately, no way has yet been found to design or control a slipring motor so as to duplicate curves *E, F, G* and *H* in Fig. 3.

Regenerative Braking Below Synchronous Speeds

In fact, there is no known way to obtain regenerative braking with speeds below synchronous speed. Where such speed control is required, some form of mechanical braking must be used or else back-torque braking must be obtained by reversing the motor.

This is because the back-torque curves show the same characteristics as curves *A* and *B* in Fig. 2 for shunt motors where the speed is unstable; that is, a large speed change results from a small change in load. The only safe way to obtain speed control with overhauling loads on an induction motor is to use a motor wound for two or more synchronous speeds. Safe running speeds can then be obtained at or about synchronous speed, regardless of the character of the load. Also, when dropping back from a higher to a lower speed, very heavy regenerative braking is obtained.

Squirrel-cage motors are frequently used in this way and, if the torque on dropping back from a higher to a lower speed is too severe, it can be reduced and applied in steps by the introduction of resistance which is automatically cut out by contactors.

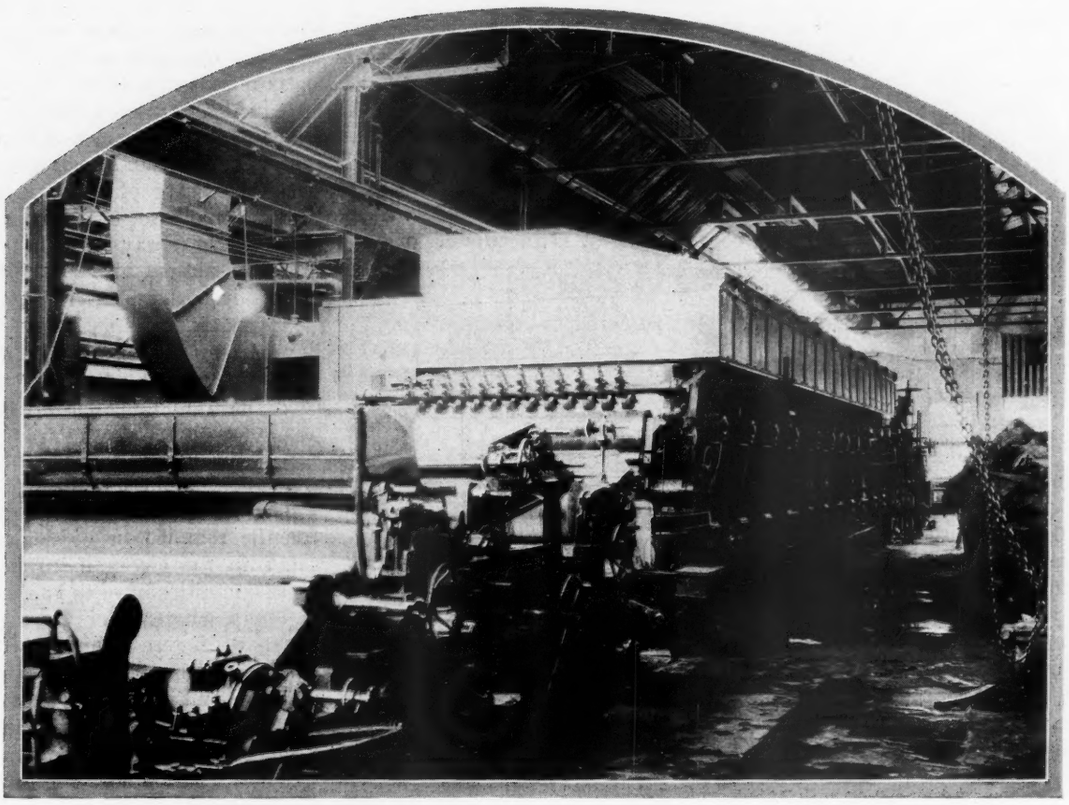
Slipring motors can be connected to give true dynamic braking by exciting two of the stator leads with direct-current and varying the resistance in the secondary circuit. This scheme, however, requires an a.c. generator for the exciting current, and its voltage must suit the winding of the induction motor.

Announcing the Annual Power and Mechanical Exposition

ONE OF THE greatest annual events of industry and engineering practice which is awaited anxiously by manufacturers of industrial equipment and kindred products is the seventh National Exposition of Power & Mechanical Engineering which will be held at the Grand Central Palace, New York, N. Y., December 3-8, 1928. It provides industry and plant engineers an opportunity for comparison of similar products so as to enable them to keep abreast of recent developments in engineering practice.

Under the classification of transmission equipment there will be exhibits of belting, belt dressing, belt fasteners, belt chain, pulleys, various types of drives and transmission units, clutches, bearings, gears, couplings and speed reducers.

Lubricants and lubricators come under the heading of tools. The heating and ventilating section will show air filters, gaskets and packing, separators, furnaces, boilers, grates and stokers, radiators, cooling towers, blowers and air conditioners. Steam specialties as well as electrical equipment are included in the power classification. Address inquiries to International Exposition Company, Grand Central Palace, New York, N. Y.



Paper mills produce large quantities of water vapor which must be removed.

Present-Day AIR-CONDITIONING *Practices*

By E. L. HOGAN

Consulting Engineer, American Blower Corp., Detroit, Mich.

WHY ARE certain things necessary today when it was possible to get along without them a few years ago? The answer is production, speed, better methods, new materials and products.

A manufacturer buys the latest, largest, fastest, most productive machinery yet made. For it to accomplish results the supplies leading to it must be increased; larger conveyors for materials, steam, air, water, electricity, and so on, must be installed. After this is accomplished there is still another barrier. Due to the increase in production per square foot of floor area, or per cubic foot of space, the dust content, the moisture, the vapor, or the fume content per cubic foot of air is unsatisfactory and must be remedied.

The candy manufacturer must have made-to-order air conditions for manufacturing and storage space. These include water-vapor removal systems for cooling vats, drying rooms, starch-dust removal systems, and so on.

The paper manufacturer with wider and speedier machines has many times as much water vapor to remove today as yesterday per cubic foot of contents of his mill, for the benefit of his workmen, his product, his building, and to permit of the increased production. Also, he has another problem, if he be a maker of fine bond and coated papers, that is, to keep the air in his plant clean.

Foundries, with their modern conveying systems, molding machines and preparation plants, create a large amount of dust and water vapor, both of which must be taken out of the working space and must not be discharged into the outside air to become a nuisance in the neighborhood.

Every institution in the world could be classified as having problems coming under at least one of the heads of this article. Further generalization is impossible, but we must add that as these problems and their solution affect building design, system of heating to be used, and also, the design and construction of equipment, it follows that one of the first moves to make is to consult an air engineer.

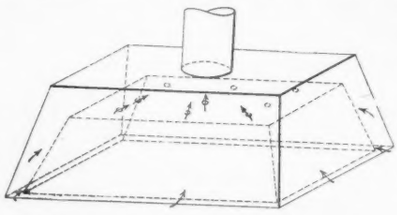
For specific problems, there are several general rules to be followed which greatly facilitate their solution.

First, confine dusts, fumes or vapors to the greatest possible extent at the point at which they are generated. If allowed to escape, the problem is many times harder and the effectiveness and efficiency less. In other words, if prevented from escaping, you have them; if allowed to mix with surrounding air complete collection is impossible.

Second, remember that air is always present in these mixtures and a certain amount must be handled. Whenever vapor, dust or fumes are closely confined, the less air must be handled; consequently smaller equipment is required, with lower first cost and operating cost. Whatever air goes out in an exhaust system must be replaced, because what goes out must come in, or it can't go out. In winter the incoming air usually has to be tempered, and in some cases humidified, both of which require fuel and in some cases considerable extra equipment.

Third, when dusts, fumes or vapors are generated at points where moving parts are in operation and create air currents, or where temperatures are quite different than the surrounding space, higher velocities of air are required at the necessary openings or open areas are required to offset the energy of motion thus created.

Fourth, nature has a number of laws which we are supposed to understand, but which most of us don't. If work is planned in conjunction with these laws the problems will be much easier than otherwise. When gases, vapors, and so on, are mixed with air and heated above the surrounding temperature, they rise; when cooled below the surrounding air they fall, whether they be confined to a chimney, smokestack or unconfined. The energy or force which they possess is known and may be counteracted by artificially created air



TYPE OF DOUBLE HOOD or canopy used over vats, cooking kettles and similar installations to remove fumes or vapors before they can escape into the room; designed to maintain a high velocity by reducing the area of the inlet.

* * * *

pressures. All problems can be solved providing the expense is not so great as to make it undesirable.

Fifth, it is impossible to eliminate, catch, or absorb most gases, vapors and fumes unless they can be condensed to a liquid, or solidified at the temperature of air or water available. As a rule odors cannot be removed from the air. Materials in the solid and liquid forms can generally be almost entirely caught or separated from the air.

Where it is desired to remove only the small amount of dust in outside air for heating or ventilating systems, we have available the air filter of dry plate design, as illustrated. (*a*) A type using loosely-made sulphite paper for screening or filtering the air, in which the paper is destroyed after use. (*b*) The wet type or oil filter having many oiled surfaces for collecting the dust in the air as it comes in contact with the surface, which is cleaned by removing the oil and reoiling, a process now taken care of automatically on the latest models. (*c*) The air washer using water sprays which not only wash the air but also humidify it, if such is desired, and in the summer, or hot weather, permits of cooling by the application of cold water through the sprays. The air washer is sometimes used in industries for removing greater dust concentrations from the air by increasing the amount of wet surface and the number of sprays.

The air washer has also been used for the removal or condensation of vapor in the air in industries when great quantities have to be discharged outdoors where in cold weather the clouds of fog resulting impede navigation or locomotion and become a nuisance and menace.

Where fumes can be absorbed by water a washer of modified design can be used and also, in cases where the fumes when cooled condense or solidify, the washer can be used to cool and cleanse the air of the material.

Generally, where there is a large quantity of dust present in the air, it is most satisfactory to use dry collectors, and for simplicity and utility, the centrifugal type stands first.

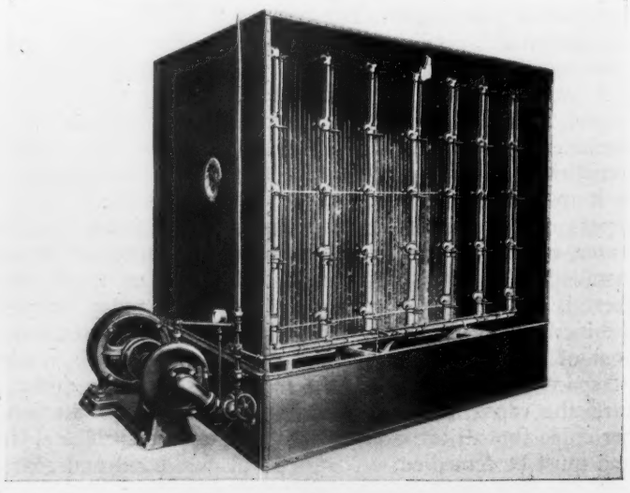
In modern power plants where the equipment is installed with the idea of operating at 300 or 400 per cent load, quantities of cinders and fly ash are discharged from the smoke stack. Where powdered fuel is used there is probably more fly ash discharged

* * * *

AIR WASHING UNITS are commonly used when all foreign matter must be removed from circulated air or for the condensation of vapors where they cannot be discharged into the open.

* * * *

DIRTY OR DUSTY AIR must be cleaned before it can be introduced into circulation in some industries to make up for the air removd with the dust, vapor or fumes. These individual cell units may be removed for cleaning.



from the stack and for the benefit of the equipment and properties of the owner of such plants this dust should be collected. Also, community and civic obligation and pride for cleanliness must be considered.

A new type of centrifugal collector is illustrated. It is not affected by temperature, or varying dust conditions such as would be ordinarily met and for extreme conditions modifications are provided. It has been applied to power plants and industries for collecting materials, such as: fly ash, cinders, powdered soap, bone dust, sand, limestone dust, garbage dust, electric furnace refractory dust, producer gas dust, bicarbonate of soda, common salt, and many others.

To illustrate the idea of inclosing sources of vapor, one of the accompanying illustrations shows a paper machine with hood, back curtain and canopy practically enclosing all but the front or face of the machine where the room air enters. This prevents the vapor from escaping into the room which, in order to offset its tendency to deposit on the cold building walls and roof and cause trouble, would require between 50 and 100 per cent more heating or supply air to be handled through the room.

An accompanying sketch shows a type of double hood or canopy used over a vat or cooking kettle. Here, owing to the freedom of access to the utensil, the hood must be located above. By providing a large hood, we completely cover the possible path of the rising vapor immediately at the source. Then to obtain efficiency a double hood is used, which limits the volume of air necessary to be handled and increases the air velocity at the possible points of escape of the vapor, namely, the edge of the hood.

WITH AUTUMN comes better weather, but shorter days in which to work and play in sunlight. Have you made your plans to brighten up the dark days? If not,

NEXT MONTH

the editors of Industrial Engineering plan to give you a special treat on Illumination Practices, in which you might find the solution to your ever present lighting problems.

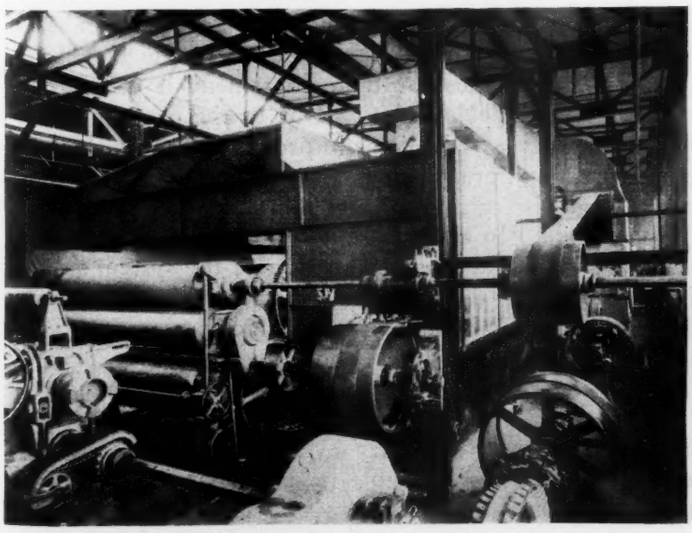
The slot or exhaust opening extends entirely around the hood and several small openings are made in the top of the inner hood to provide some circulation of air through them. One can readily see that a high velocity can be maintained at the openings. This prevents the escape of the vapor with a minimum quantity of air to be handled, and so reduces the size of the ducts and equipment and keeps down the first cost and operation cost.

In paper, textile mills and places where large quantities of water vapor and air are exhausted (consequently an equal quantity of air must be admitted to the plant) considerable economy can be obtained, especially in cold climates, by installing interchangers, or air economizers, which contact metal surfaces with the outgoing hot moist air and the incoming cold air. This cools the one and heats the other, thus saving a considerable amount of fuel during the heating season. Similar means have also been used to heat water for manufacturing purposes by utilizing waste heat in exhausted hot air and vapor.

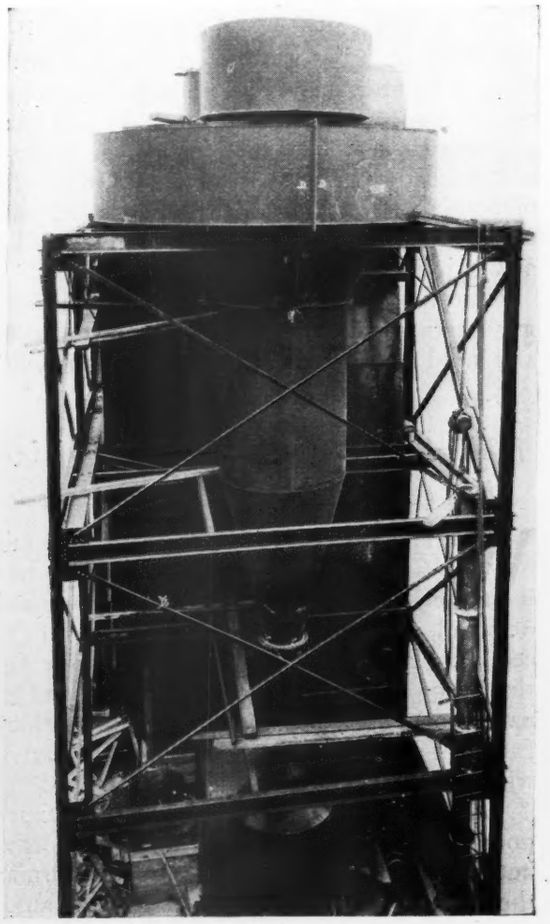
In connection with exhaust systems of all kinds an ounce of precaution in confining dust, fumes and vapors, and getting them out is worth a pound of cure; if they are permitted to escape the problem of trying to collect them or offset their effects is heavily increased.

* * * *

BY ENCLOSING the source of vapor, as in this paper mill installation shown below, the vapor does not escape into the room and so less air must be removed. Also, by double-jacketing, the incoming air is heated by the removed air.



NEW TYPE of centrifugal separator or dust collector which, it is said, is not affected by temperature and varying dust collections. Here it is used for collecting cinders from the power plant at an automobile factory.



INDUSTRIAL ENGINEERING
with which is consolidated
INDUSTRY ILLUSTRATED
Electrical, Mechanical and Plant Service in Industry
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Don't Overlook the Wheat in the Chaff

THE enthusiast is often a nuisance. So many of his enthusiasms are impractical, that it often becomes second nature to frown him down without troubling to analyze his idea of the moment.

One of these chaps—most plants can boast of one or more—conceived a wild enthusiasm, about a year ago, for painting all the machinery in his department a light color. Neither the plant engineer nor the management was particularly sold on the idea, but it happened to be a slack period, a number of the machines did happen to need painting, and for once enthusiasm had its way.

Today, every department in that plant has adopted the idea. Not only that, but the management has become an enthusiast on the subject. Like most radical changes, it wasn't merely the change itself, but the train of things that followed in its wake, which mattered.

Better appearance was the first result. But this, and better lighting were taken for granted before the job was begun. It was not many weeks, however before comparative records showed the plant engineer a distinct tightening up in maintenance and inspection in that one department; and simultaneously the production records pointed to an improvement there. Hence the decision to adopt the new painting policy throughout the plant.

Nine times out of ten, the perennial enthusiast may be an impractical pest; but keep your eyes, ears and mind open for that profitable tenth time.

Will the Lowest Price Buy Satisfactory Service?

WHEN a plant is in the market for equipment of any sort, the natural tendency is to secure it at the lowest price. That is simply good business and, within limits, is a perfectly justifiable procedure. Plant men who are responsible for continuity of service and low operating and maintenance costs may, however, well stop to think how far it is safe to go in running down that elusive will-o'-the-wisp, "lowest price."

Designing skill backed by years of experience, good materials and good workmanship cost money, but are inevitably reflected in the performance of the equipment. If the price that the manufacturer can obtain is too low to cover all of these desirable elements, one or more of them must be slighted to a greater or less extent. The result is obvious.

Countless plant men have found by sad experience that bargain counter equipment is usually the most expensive in the end. Deficiencies in design, materials or workmanship invariably lead to production delays and high repair costs that may amount to a surprising total in a comparatively short time. Then savings in first cost become merely deferred payments that are collected, perhaps many times over, every year that the equipment is in service.

A low price is not always evidence of shrewd buying; it may merely show ignorance or a willingness to sacrifice trustworthy performance for a few dollars.

Is Heating Without Waste an Impossibility?

JUST as soon as it gets cold this fall, there is going to be a lot of waste in heating in an effort to properly heat certain places around the plant. Discomforts of previous winters are usually forgotten in the heat of the summer, but the first touch of frost acts as a tickler system in refreshing memories of the old timers who have accepted the comforts of modern industry.

Certain things are necessary today when it was possible to get along without them years ago, but heat is not one of them, yet some plants unintentionally, or otherwise, cling to the old heating, catch-as-can methods with pennywise folly that heat cannot be controlled in large areas regardless of the capacity of the system. As a matter of fact, it can, and without waste or impairment of ventilation. The outgoing hot air can be controlled to contact with metal surfaces to add heat to the incoming cold air thus saving a considerable amount of fuel during the heating season.

Two of the most common causes of waste in heating are failure to learn just where the trouble is and what must be done to remedy it other than repairing leaky joints. Due to the growth of the plant the system demand probably exceeds the supply, or in practicing economy the homemade equipment is entirely inadequate and improperly installed. In either case it is not only good business but common sense to investigate the system as you would the distribution of power. If your organization is limited, most manufacturers maintaining inquiring departments for the purpose of making recommendations in specific cases would gladly lend their assistance. There is no need to accept heating waste as a necessary evil with help around the corner. Nor will hot air in the office heat the cold corners in the plant.

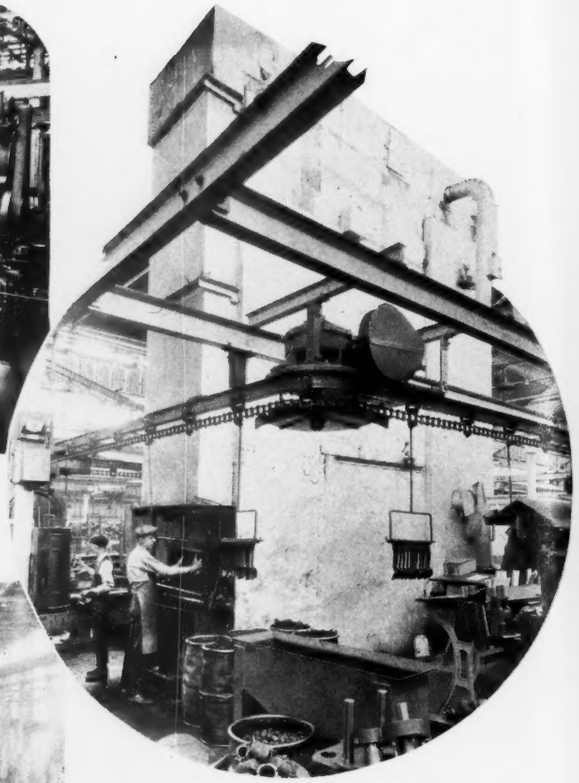
Highlights on FORD HEATING and VENTILATING Practices

THE FURNACE END of the glass plant, showing the four furnace stacks and the unique roof and ventilator design for maintaining bearable temperatures in the plant. Forced draughts of cold air are used at strategic points inside the plant.

ONE OF THE SMALL outlying plants, the Phoenix plant. Note how modern sash provides comfortable ventilation here, where women are employed.

A GENERAL VIEW of one of the Ford stores, showing the heating and ventilating provisions, and emphasizing the general atmosphere of cleanliness.

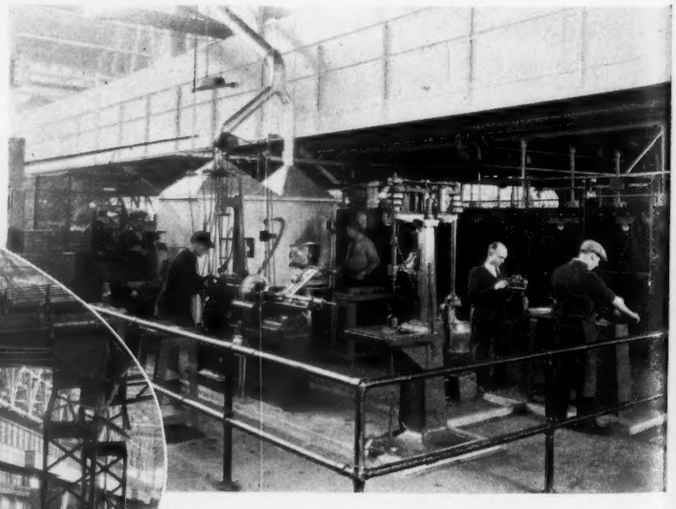
In this general view of the forest of presses in the pressed steel building, note the heating coils run just under the roof.

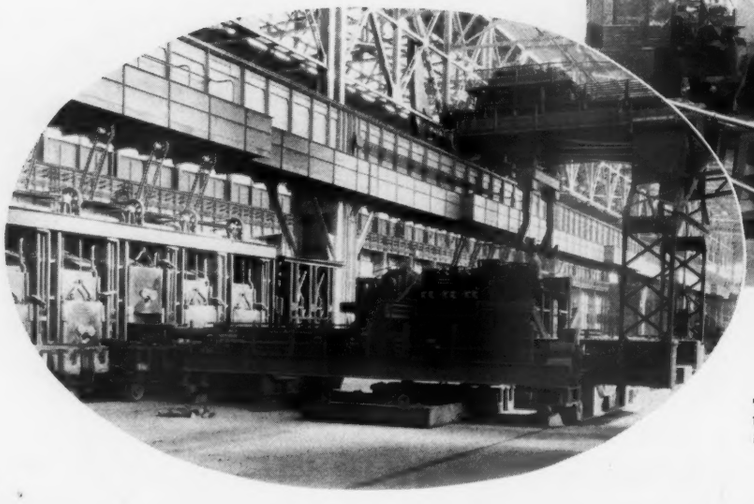


All enameling and lacquering operations are provided with suction ducts to carry off the fumes.

High vaulted ceilings and adequate ventilation provisions, together with exhaust hoods over the heat treating and similar processes, make this immense machine shop a comfortable working place.

Note the exhaust hoods provided over the heat treating operation here; preventing poisonous gases from mixing with the air in the building.

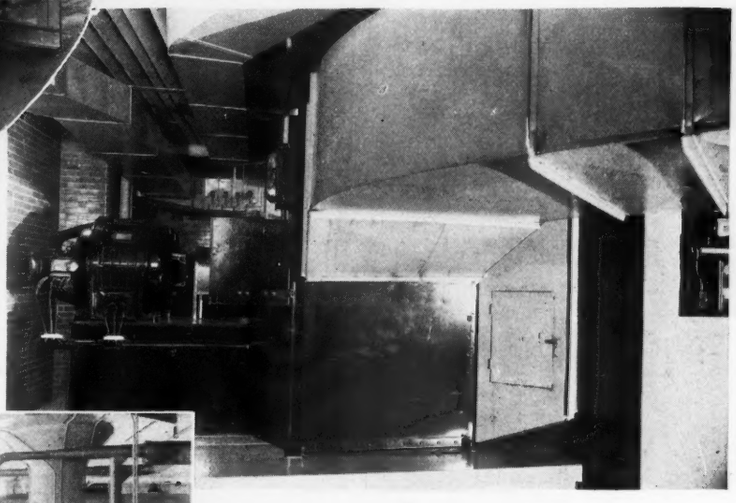




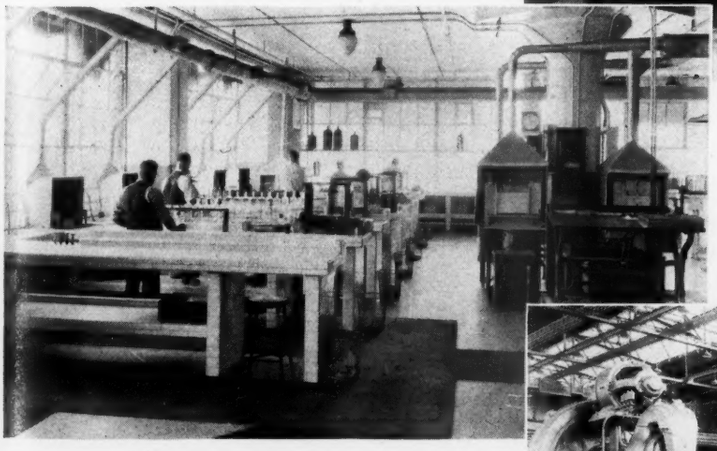
The steel mill itself requires no heating provisions, but the clearness of this illustration is ample evidence of good ventilation and lighting.

Note the overhead heating system in this large tool room, as well as the clear atmosphere which is strikingly evident in the illustration. The M shape monitor roof is largely responsible for the latter.

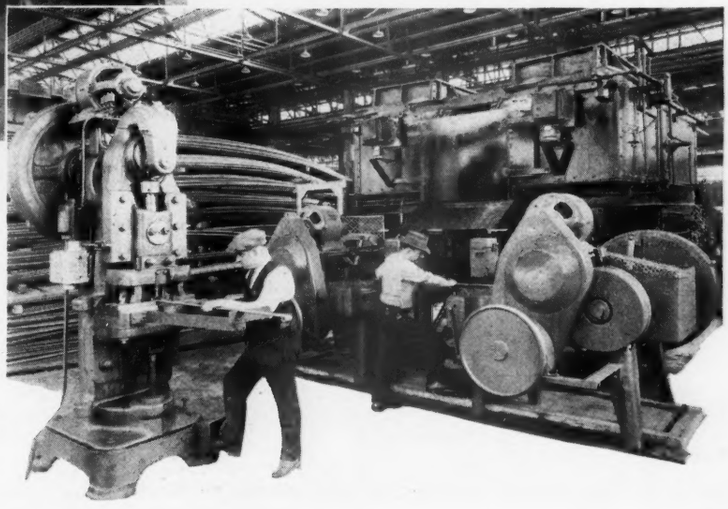
Electric furnaces, substituted for gas furnaces in forging operations, have done away with the need for exhaust systems in such cases as this.



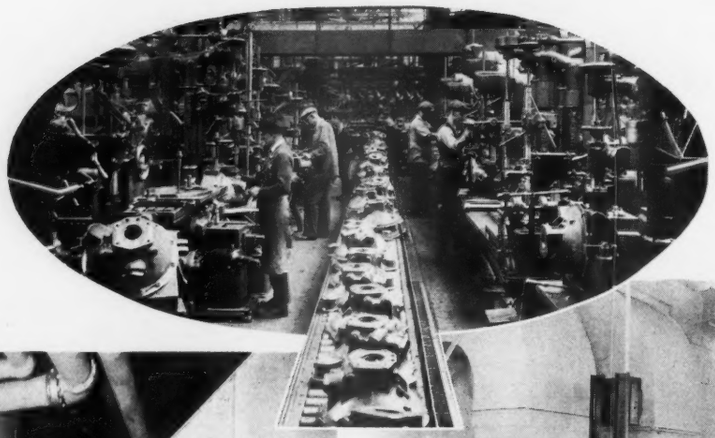
The fresh air inlet, fan and motor, in the penthouse of the administration building; part of an elaborate ventilation system for that building.



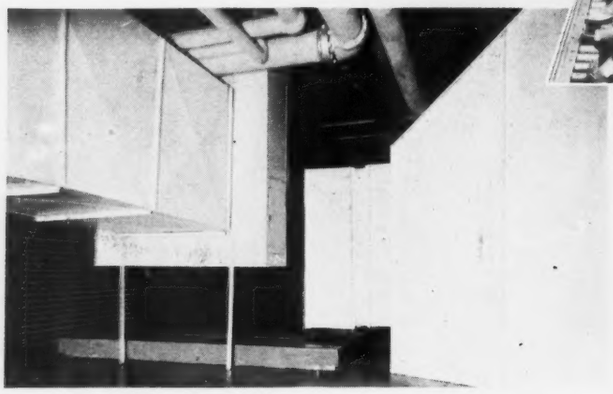
Exhaust hoods over the electric furnaces and at the benches in the laboratory help to keep the atmosphere here, too, as clear as in other parts of the Ford plants.



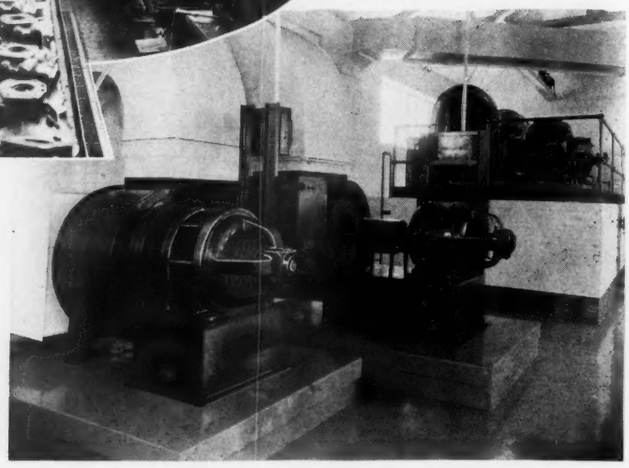
One of the furnaces for preheating the ends of the main spring leaf preparatory to rolling the eye. In this building, overhead steam coils and natural ventilation through the M type roof maintain ideal working conditions.



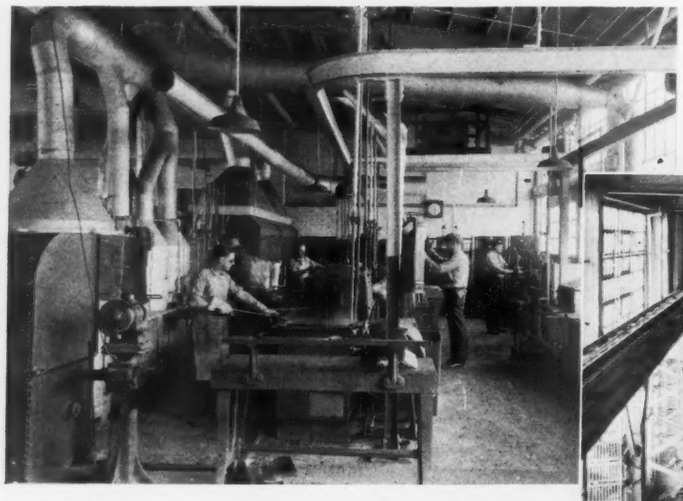
Although machines seem crowded, men are not cramped for room. Here, in spite of the fully utilized floor space, fresh air and comfortable temperatures are provided.



Here is part of the basement of the administration building, showing the suction duct, exhaust fan, and discharge duct.



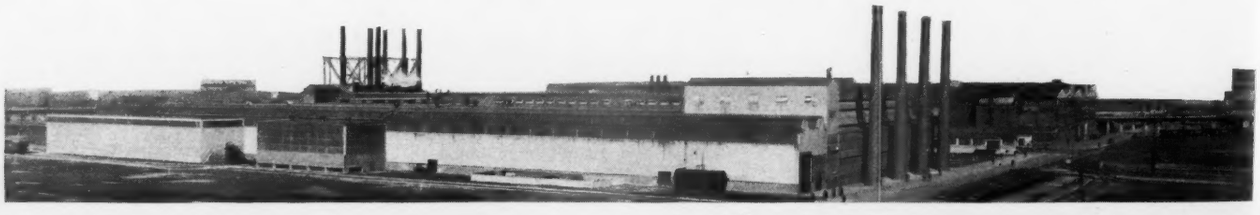
Exhaust fans in the penthouse of the administration building, which is designed and equipped for up-to-date ventilation.



Here is another heat treating section in one of the Ford shops. Note how efficient ventilating practice keeps the air clear.

A general view of the foundry tool room, showing wall radiators at the left, clothes racks on the mezzanine at the right, and again emphasizing the absence of smoke and dirt in the air.

A more distant view of the glass plant, with the "B" building in the background, and showing the M shape roof construction.



The COMMUTATOR ASSEMBLED

How the finishing touches are put on the new and repaired commutators

By JESSE M. ZIMMERMAN

Fig. 1—After assembly, commutators should be given a test of 600 volts between bars and 4,000 volts to ground.

* * * *

IN THE PRECEDING article, in the August issue, the advantages and disadvantages of the different types of commutator construction were discussed in detail. In this article the procedure followed in assembling commutators will be considered.

In a large number of repair shops insufficient attention is paid to the assembling of commutators, although from the maintenance standpoint this is a very important operation. A tight-fitting commutator can be obtained only if the parts are accurately machined and assembled in a systematic manner. For present purposes it will suffice to describe the assembling of a V-bound commutator, as the procedure in assembling the arch-bound type is practically the same.

The steps involved in assembling a commutator are as follows: First fit the steel V-ring over the spider. Some filing may be required to remove paint and rust. Try the commutator nut on the bushing. It may be necessary to clean out the threads of the bushing, to allow the nut to be screwed up by hand. Then, when the detachable V-ring is under pressure, the commutator nut can readily be run up against it, thus retaining it under pressure.

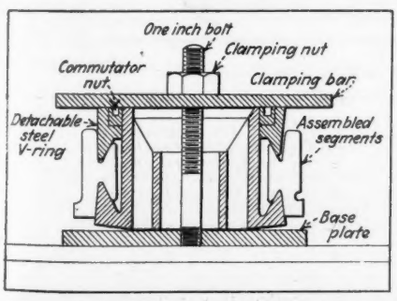


FIG. 2—USE of a clamping plate like this will prevent skewing of the commutator bars. This device can be used to tighten small commutators, but a press should always be employed for large ones.

Clean out the V's in the assembled segments with fine sandpaper. Do not scrape with a knife, as this may result in depositing copper over the mica. Then blow out the dirt and check for short circuits with 600 volts between bars. After the V's have been thoroughly cleaned and tested, brush them with a thin coat of shellac.

Thoroughly clean the mica V-ring with sandpaper, especially at the fit of the V's. After the surface that touches the copper has been well cleaned it should not be touched by hand or anything else. This will eliminate the possibility of dirt or moisture getting on the ring and causing a short circuit between bars after the commutator has been assembled.

Now stand the armature upright, with the commutator spider up, and assemble the rear mica V-ring. Place the assembled segments on the spider and assemble the detachable front steel and mica V-rings. The 3-deg. angles of the mica V-rings will bind against the corresponding angles of the copper V's before the banding wire is removed. Do not try to force the front mica V-ring down; to do so will injure the mica.

Locate the commutator nut (or bolts, if it is of the bolted type). It is probable that the threads of the nut (or bolts) will not catch the threads on the bushing.

Next, tie two pieces of cotton tape around the segments, one above the top banding wire and the other below the lower banding wire. The commutator is now ready to be put under light pressure so that the nut or bolts can be tightened sufficiently to hold the assembly together.

When the commutator spider has not been pressed onto the armature spider the commutator can be tightened and skewing of the bars pre-

vented by placing the commutator on a clamping plate, shown in Fig. 2, while tightening.

This device consists of a steel baseplate, a bolt and a clamping bar. After the bars have been properly aligned the commutator is placed on this plate and the clamping bar drawn down. This bar serves as a press and prevents the detachable steel V-ring from turning. Several blows with a rawhide mallet on the V-ring will cause it to take its place. After the clamping bar has been drawn tight the commutator nut can be tightened.

When the commutator spider has been assembled on the armature spider, the press shown in Fig. 3 may be used to tighten the commutator nut prior to the heating and final tightening.

When using this press the armature shaft is inserted in the hole in the base plate. Provide the necessary collars so that the armature will be supported from the wiper ring face and not by the extreme end of the flange of the wiper.

The U-shaped clamping bar is then placed over the shaft so that it rests on the detachable steel V-ring, and the necessary pressure is applied by screwing the bolts down. The commutator nut is then screwed home.

Now cut the lower and then the upper banding wires; after each wire is cut, again take up the slack by tightening the clamping nut. Opened-up places will appear between the bars when the banding wire is cut. These cracks will disappear when the commutator is heated and subjected to pressure.

Check the alignment with a square. The bars should not be out of alignment more than the width of a mica strip. Then align the center line of the mica strip (or copper bar, as the case may be) with the center line of the armature slot or tooth.

Correct alignment of the commutator bars with respect to the center line of the starting coil is very important, as it will insure the correct location of the neutral commutating zone, when rewinding the armature. If the commutator bars are not correctly aligned with the center line of the armature coil the neutral commutating zone will be shifted. This will produce the same results as shifting the brushes the same distance in the opposite direction.

Shifting the commutating zone will, of course, cause the motor to operate at a higher or lower speed than normal, depending on the direction of rotation. This may or may not be important, but it will also cause sparking and flashing.

UNDER the best of conditions, commutators have to perform a difficult and exacting function. Poor materials or poor workmanship in manufacture or assembly lead inevitably to operating troubles that are annoying and costly to remedy. In the preceding articles of this series, which have appeared in the December 1926, April 1927, December 1927, and August 1928 issues, the selection of the materials and the salient features of commutator design in relation to service requirements, were discussed. In this article, which is the last of the series, the author discusses the detailed procedure in assembling and testing new and repaired commutators.

A simple aligning tool can be made from a straight-edged bar about 1 in. wide with two stationary and one movable pin so spaced along the center line of the bar that the two stationary pins will rest on the center line of the armature tooth, while the movable pin will be above the commutator. This tool is inexpensive and easy to make, and can be used on all types of armatures.

The center line of the keyway in the commutator bushing is usually the center line of a slot in the armature core. This definite relation is maintained by the relation between the common center line of the keyways in the armature spider, the commutator bushings, and the armature punchings.

An aligning tool that can be made to fit all the commutator spider keyways by using different sizes of dummy keys as shown in Fig. 4. The right-angle bar is made so that the inside of its vertical bar is the center line of the dummy key, which would make it the center line of the keyway in the commutator bushing. This relation, in turn, makes the inside of the adjustable bar the center line of the dummy key.

The dummy key fits the keyway in the bushing. The gage is held in place by a simple, adjustable-pressure screw. In the commutator shown in Fig. 4 the center line of the keyway must line up with the center line of a commutator bar. If the center line of the bar coincides with the inside of the adjustable bar, then the center line of the commutator bar will be in alignment with the center line of the armature slot when the bushing is pressed onto the armature spider.

If the center line of the mica must align with the center line of the keyway the inside of the adjustable gage

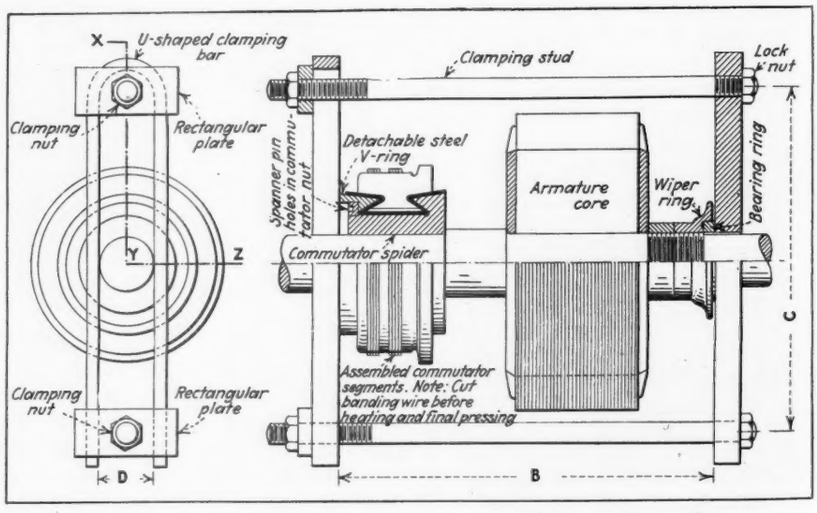


FIG. 3—THIS PRESSURE CLAMP can be used for assembling and tightening the commutators on motors of 30-hp. rating and under, when the commutator assembly is on the armature shaft. The base is a piece of flat heavy steel and should be anchored to a level foundation. The posts or studs should be about 30 in. long and threaded on both ends; the upper thread should be about 12 in. long. The clamping bar is U-shaped, as shown at the left.

* * * *

must coincide with the center line of the mica.

When the commutator is properly aligned, tap lightly on the metal V-ring with a rawhide hammer and again take up the slack by tightening the clamping bolts, and then the commutator nut or bolts.

Do not try to give the final tightening of the assembly with the commutator nut while the assembly is cold. To do so will injure the mica V-rings. Also do not try to tighten the assembly with the commutator nut without applying pressure to the detachable steel V-ring, as it may turn with the nut and thus skew the bars.

The commutator is now ready to be heated in an oven or otherwise to a temperature of 125 to 150 deg. C. The maximum temperature should not exceed 150 deg. C.

If an oven is not available, commutators that have not been pressed onto the armature spider can be heated on the simple stand shown in Fig. 5. The hole in the base of the stand should not be larger than the opening in the commutator spider. This opening will allow the flame of a gas torch to pass through the spider. An asbestos board, with a hole for the hot gas to escape, should be placed over the top of the detachable steel V-ring. It is not advisable to use a sheet steel plate here as the heat will warp it and allow the flame to pass between the plate and the detachable V-ring, thereby burning out the bond.

The temperature should be measured with a thermometer placed on the copper bars next to the V-ring, with the bulb covered with putty. This arrangement will give a true indication of the temperature of the copper, which should range from 125 to not over 150 deg. C.

In cases where the commutator spider has been pressed onto the armature spider, the commutator should be heated, before assembling, to 125 or 150 deg. C. This heating operation is necessary in order to soften the bond in the mica V-rings and the commutator strips. Subjecting mica to pressure while it is cold will pulverize the bond. On the other hand, heating softens the bond and allows the mica to conform to the shape of the metal parts when pressure is applied. This is the only reason for heating a commutator.

When applying heat it is always best not to allow a flame to touch the commutator; hence an oven should be used, if possible. However, when an oven is not available the flame will have to be played to some extent on the copper. Therefore, before starting to heat the commutator the mica-V-ring should be covered with asbestos cloth so that the flame will not burn the bond in the mica.

After a commutator that has not been assembled on the armature spider has been heated and the bars aligned, it is ready to be placed in a vertical press, with the front of the commutator up. A simple ratchet wrench can be used to tighten the bolts of a bolted commutator after the necessary pressure has been applied to the detachable V-ring. However, it is more difficult to tighten the nut on a ring-nut commutator while applying pressure to all parts of the detachable V-ring. For this reason use is made of a ratchet wrench that consists of three major parts: the ratchet ring, the pressure ring, and the handle. This wrench is shown in Fig. 6, which illustrates the construction and method of using.

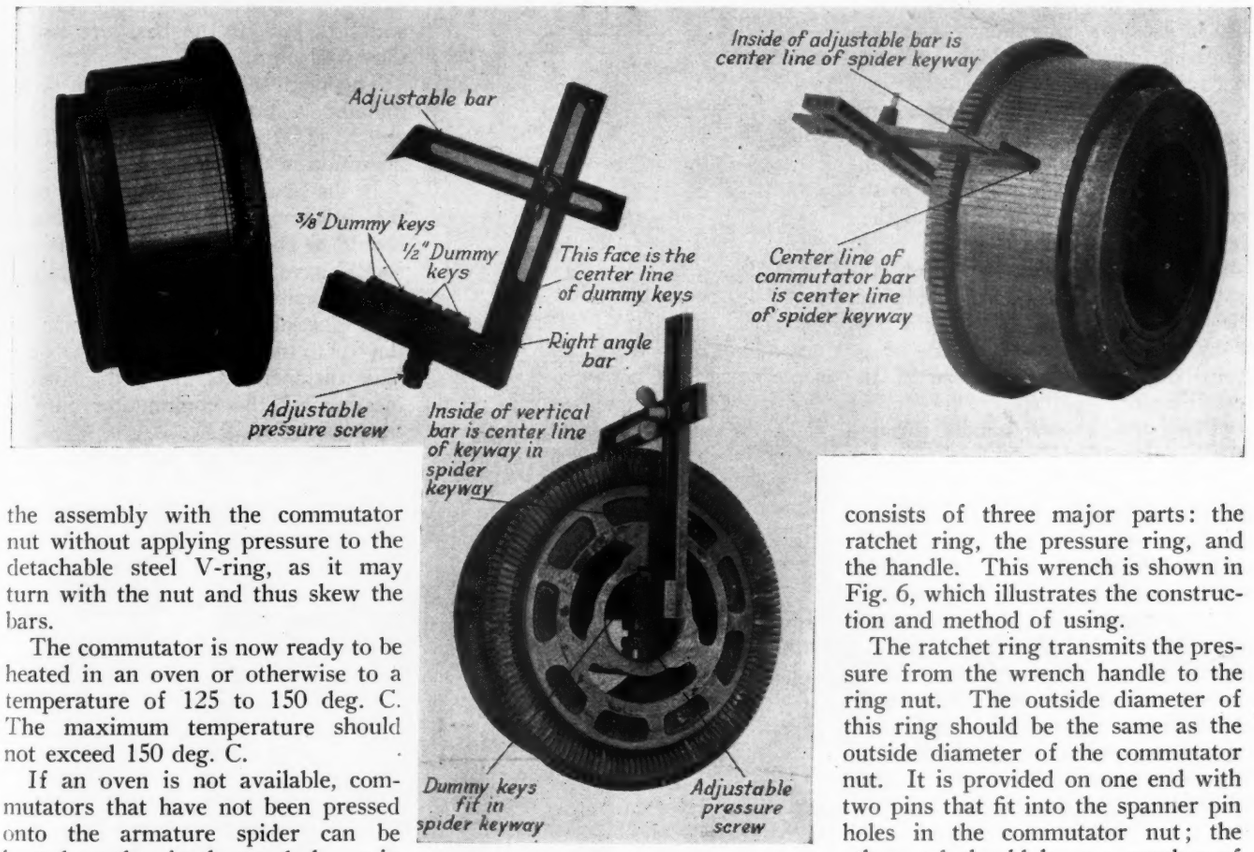

Adjustable bar
3/8" Dummy keys
1/2" Dummy keys
This face is the center line of dummy keys
Right angle bar
Adjustable pressure screw
Inside of vertical bar is center line of keyway in spider keyway
Dummy keys fit in spider keyway
Adjustable pressure screw
Inside of adjustable bar is center line of spider keyway
Center line of commutator bar is center line of spider keyway

FIG. 4—ALIGNMENT of commutator bars can quickly be checked with this gage. The construction of the gage is shown in the upper left hand view. The views above and at the right show the methods of aligning the commutator bars with respect to the keyway.

* * * *

The ratchet ring transmits the pressure from the wrench handle to the ring nut. The outside diameter of this ring should be the same as the outside diameter of the commutator nut. It is provided on one end with two pins that fit into the spanner pin holes in the commutator nut; the other end should have a number of pins or slots, to take the pressure of the wrench handle.

If a horizontal press is to be used, it will be advisable to bolt the ratchet ring to the commutator nut; therefore, two $\frac{1}{4}$-in. holes should be drilled through the ring on the same circle and diametrically opposite from the spanner pins. Two corresponding holes should be drilled and tapped in the commutator nut, for the holding bolts.

If a vertical press is used it will not be necessary to bolt the ratchet ring to the commutator nut, as the weight of the ring will keep the spanner pins in their holes in the commutator nut.

The pressure ring is used to transmit the pressure from the press to the detachable steel V-ring during the tightening operation; therefore, the

face that comes in contact with the V-ring must be smooth in order to transmit the pressure evenly. It is necessary to cut an opening in the other end of this ring for operating the wrench handle, as shown in Fig. 6.

The outside diameter of this ring should not be smaller than the outside diameter of the steel V-ring. The inside diameter should be small enough so that the pressure face of the steel V-ring is covered.

The wrench handle should be curved at one end to fit around the shaft. The straight end of the handle can be used on commutators that are assembled before the spider is pressed onto the armature spider.

The first step in tightening a commutator on a vertical press is to place the ratchet ring so that the two spanner pins will engage the holes in the commutator nut. The ring can then be bolted to the nut, if desired. Next, slide the pressure ring over the ratchet ring so that the solid side will be against the steel V-ring and then subject it to a pressure of 20 or 30 tons, depending on the size of the commutator.

Place the wrench handle through the opening in the pressure ring and with the curved end of the handle bearing against the shaft, draw the commutator nut home.

For various reasons some repair shops do not care to spend the money for a commutator wrench or press. In such cases the press shown in Fig. 3 can be used satisfactorily for tightening the commutators used on the motors up to 30-hp. rating. Likewise, the clamping bar illustrated in Fig. 2 will give sufficient pressure to tighten small commutators. However, for large commutators it will be necessary to use a press and the wrench described above.

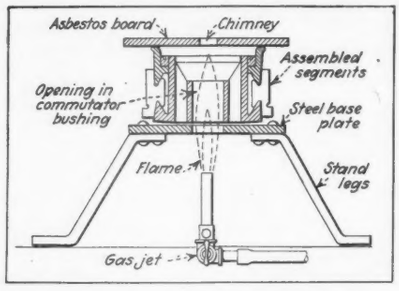


Fig. 5—WHEN no oven is available, commutators may conveniently be heated on a stand like this.

* * * *

It is bad practice to tighten the commutator nut with a special drift and a heavy hammer without first applying pressure to the steel V-ring. This procedure will batter up the commutator nut and V-ring and also tend to turn the V-ring, which in turn will skew the bars. The commutator nut should never be tightened until the assembly has been heated and the steel V-ring subjected to pressure.

After the commutator has been tightened and allowed to cool, test for loose bars by tapping them on the end. If any of the bars are loose, they will vibrate.

The next step is to give the commutator a 600-volt bar-to-bar test and a 4,000-volt ground test. This operation is shown in Fig. 1.

In the final testing of a commutator the following important dimensions should be checked. These dimensions should have been recorded before the old segments were removed:

1. The distance from the rear of the bar to the rear end of the bushing. This distance determines the correct location of the commutator in the final assembly.

2. The width of the neck. This will determine whether the clearance between the brush-holder and the neck is correct.

3. The length of the face, to make sure that the brush surface is of the proper width.

4. The outside diameter of the face, to assure the proper clearance between the brush-holder and the commutator.

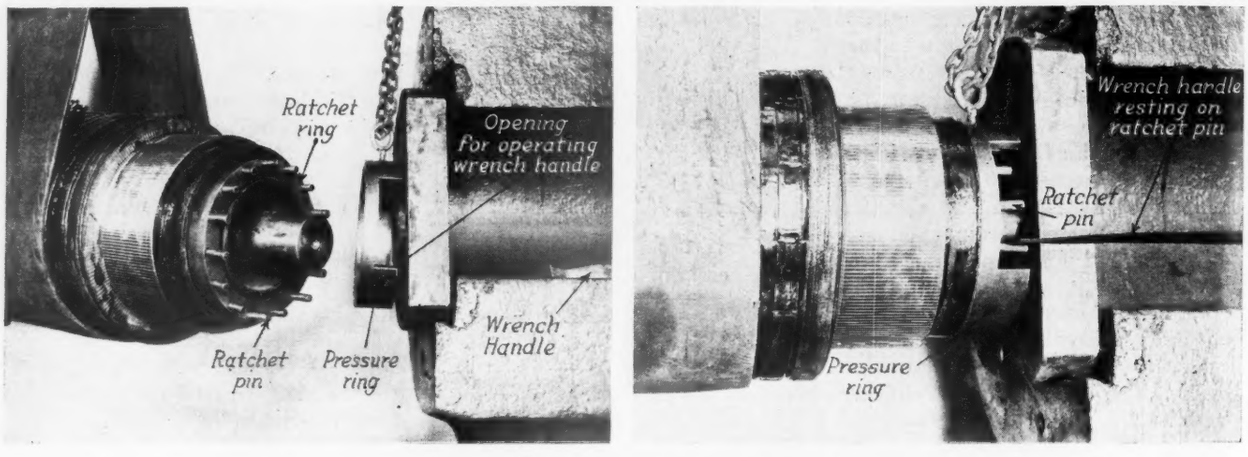


FIG. 6—CONSTRUCTION of commutator wrench and method of using it. The view at the left shows the ratchet ring in place over the commutator nut. Two pins on the back of the ratchet ring fit into the spanner pin holes in the commutator nut. If a horizontal press is used it is advisable to drill and tap two additional holes in the nut for bolting the ratchet ring in place. In the view at the right the pressure ring has been slipped over the ratchet ring and bears on the detachable steel V-ring. The wrench handle, which is curved at one end to fit the armature shaft, is slipped through the slot in the pressure ring and under the shaft. The commutator nut is tightened by bearing down on the handle, against the pressure pins.

* * * *

* * * *

draw the commutator nut home while the assembly is hot and under pressure.

It is possible to use the press without the commutator wrench, by applying pressure to the steel V-ring and tightening the nut with a drift. However, this is more difficult to do and the results will not be so good.

In the case of commutators that have been assembled on the armature spider, the ideal method of tightening is by the use of a horizontal hydraulic press, after the commutator has been heated. The armature should first be supported in a sling and the ratchet ring bolted to the commutator nut. Next, slide the pressure ring over the ratchet ring, adjust it in place, and apply the necessary pressure. Then

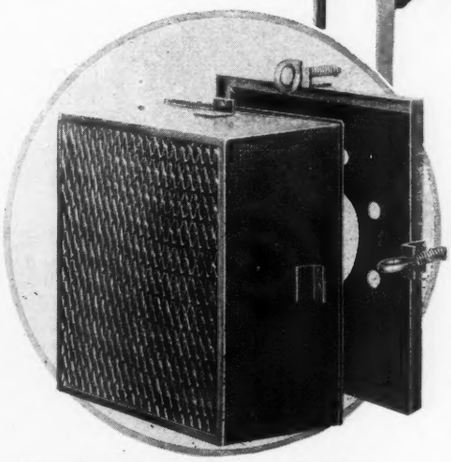
FILTERED AIR *As an Aid to* EFFECTIVE LUBRICATION

OPERATING a cleaning and charging tank. Note the drain table which is designed to drain four cells at the same time.

By ALLEN F. BREWER
Mechanical Engineer, The Texas Co., New York, N. Y.

IN THE interests of effective lubrication, it is an accepted fact that protection of lubricants from contamination with foreign matter must be provided for with every facility available. This holds true not only during the storage and handling period, but also, whenever possible during operation.

The several varieties of oil filters and purifiers on the market, all take care of this to a certain extent, but only after lubricating oils have become more or less contaminated. The air filter, on the other hand, affords a means whereby contaminating dust and dirt which might be carried into a lubricating system by circulation of air, can be removed before it has a chance to gain entry into the oil in service.



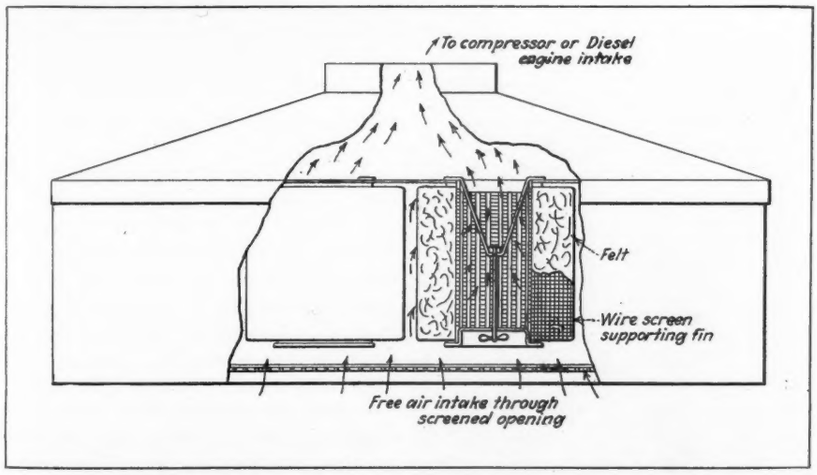
DETAILS of a typical filter cell, showing frame for adjustment over air intake, and spring locking latches. A felt sealing strip prevents leakage, and insures all air passing through the filter media.

* * * *

For a lubricating film to be effective it must be perfect in structure. Breaks such as might be caused by particles of dust and dirt may easily result in imperfect lubrication due to the occurrence of solid friction between the bearing surfaces and such particles of foreign matter as may be present. To a certain extent this explains the scoring of shafting and bearings in many plants.

There is, in consequence a direct relationship between lubrication and air, for the majority of the contaminating foreign matter which enters lubricants, lubricating systems and machine wearing parts is carried in by the surrounding air.

As a result, wherever possible attention must be given to the matter of cleaning such air periodically or continuously, according to the machinery involved. In the case of air compressors, oil engines, trucks, bus or tractor engines, where air must be taken into the engines or compressors, it is essential that it be practically free from abrasive foreign matter, in order to prevent subsequent scoring of cylinders, faulty valve action or accumulation of deposits.



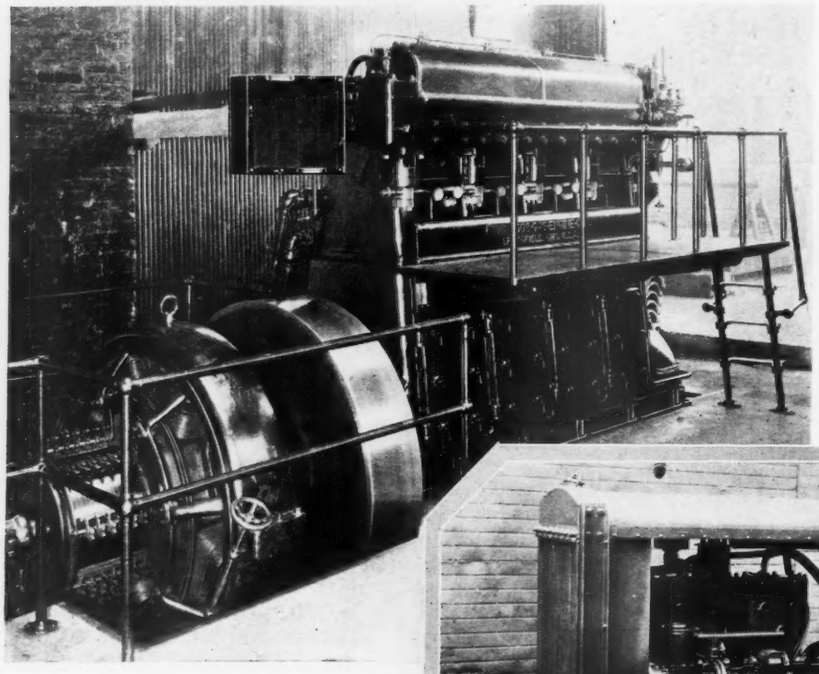
CUT-AWAY VIEW of an oil engine air filter, showing passage of air, details of insert construction, and wire screen supporting fin.

Bearings of electric motors, blowers and other equipment involving drafts to any extent should likewise be operated wherever possible under clean air conditions. Construction, of course, has a material influence upon the entry of dust or dirt. Motors especially will very frequently have their bearings designed with a view towards effectively sealing both the lubricating systems and the windings against the entry of dust. Baffles and dust guards serve this purpose in many cases most successfully.

Other types of industrial shaft or journal bearings, however, will not be so carefully protected. Of course, they may not be subjected to as high

rotational speed; on the other hand, they will require quite as perfect lubrication as the electric motor.

For example, take a burned out line shaft bearing, due to entry of abrasive particles from a grinding tool. Frequently dismantling of a considerable part of the transmission system may be necessary simply to renew one such bearing. The expense involved would naturally be a decided item; furthermore, there would be time and production loses due to the idleness of adjacent equipment in many instances.



THE COMPACTNESS of an oil engine air filter installation, and amount of space required, is clearly shown above.

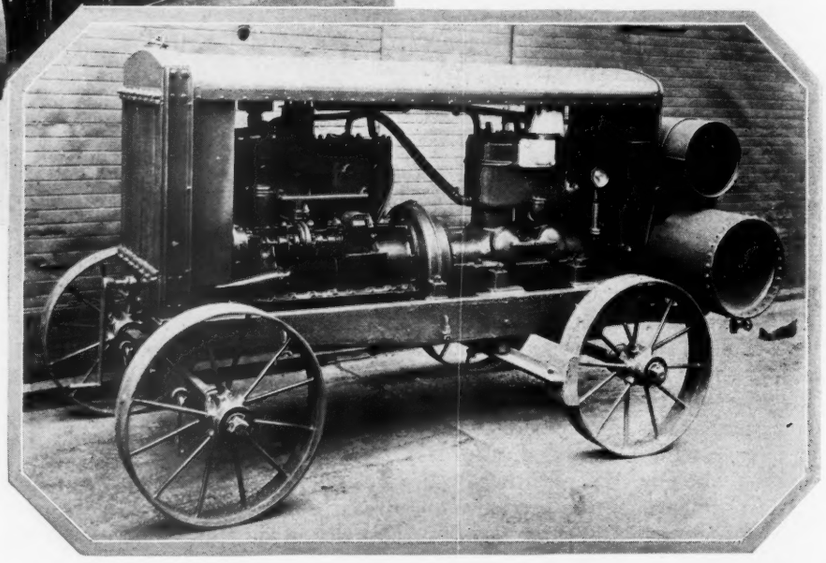
* * * *

It is therefore important to maintain plant atmospheric conditions as cleanly as possible at all times, to protect both lubricants and the lungs of the operators. In many cases dust and abrasive particles can be removed at the source by the installation of suitable hoods, as are often used over grinders or pulverizers, in connection with suitable suction equipment and filters wherever necessary.

Elsewhere the air as drawn into blowers prior to circulation can be drawn through filtering devices capable of removing practically all entrained dust particles.

Equipment where air plays a part in operation such as the air compressor, for example, involves an outstanding problem in case it is not continuously supplied with as clean air as possible. Air compressor operation, to be efficient, requires that valves, intercoolers, after-coolers and lines be practically free from dirt and carbonaceous deposits. Of course, part of such accumulations of foreign matter may be due to decomposition of the lubricating oils used for cylinder lubrication, especially where such products have a comparatively high carbon content. On the other hand, air compressor difficulties such as overheating of air lines, or explosions, may be regarded as due to the continued compression of air which contains a comparatively high percentage of dust or fine abrasive particles.

Of course, location has a lot to do with the original cleanliness of the air and the nature of the contaminating foreign matter. Close to the ground any foreign matter will probably be chiefly of an earthy nature. In elevated positions, however, it may be of a more abrasive character, consisting of fine particles of ash, fuel dust, etc.



AN AIR COMPRESSOR equipped with a felt vane air filter. Note comparative size of the latter and its accessible location.

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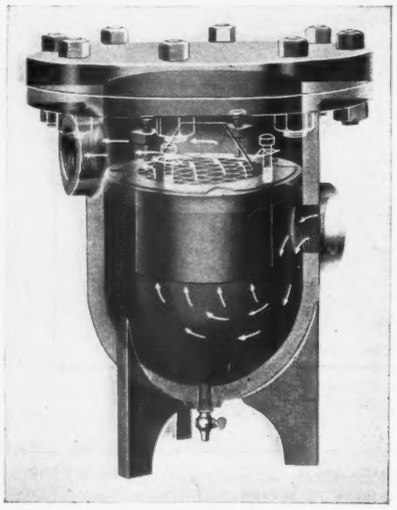


CUT-AWAY VIEW of a single cell air filter showing path of air. The filtering media is split wire coated with a suitable dust-retaining fluid. Cleaning can be readily accomplished by removing the top cap as shown. Note drain plug in the base.

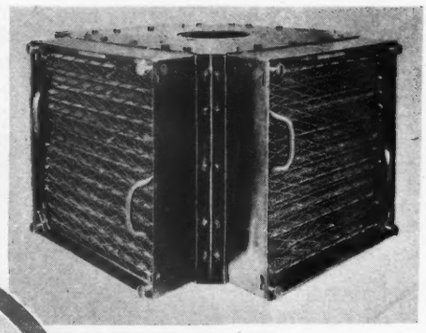
The air filter as usually designed for industrial or power plant service will involve an arrangement of fine wire or metallic particles, ranging in decreasing fineness from the intake side outward; or a set of felt vane inserts. According to the type of filter, coils of wire, densely compacted expanded metal sheets, small metallic cylinders or fibrous wire much like steel wool or felt fabric, may be used as the filtering media. The entire mass is inserted or firmly packed into a suitable frame to form the cell or unit.

By virtue of the design and the construction the direction of the air is changed a number of times. Each change in direction, of course, causes

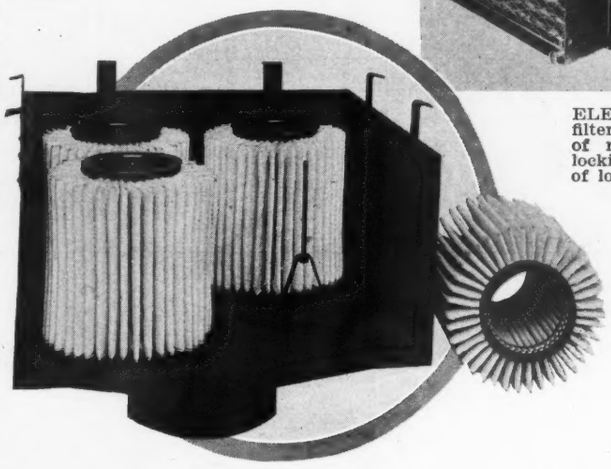
a certain amount of impingement against the surface of the filtering media. In order to enable this action to more effectively separate dust from the air, metallic surfaces where involved are usually coated with some fluid such as a light lubricating oil, or other viscous solution.

Continuous filtration of such air will cause a gradual accumulation of dirt within the media, to thereby present a certain amount of resistance to flow of air and ultimately reduce the efficiency of the filter. The cells should, therefore, be periodically removed, cleaned and recharged. Cleaning of dust and old absorption fluid can be effectively carried out by washing in hot soda solution. This will cut or dissolve the film of fluid and at the same time loosen and remove dirt accumulations. The cells can then be recharged or the film of absorption fluid renewed on metallic filters by dipping in such a bath.

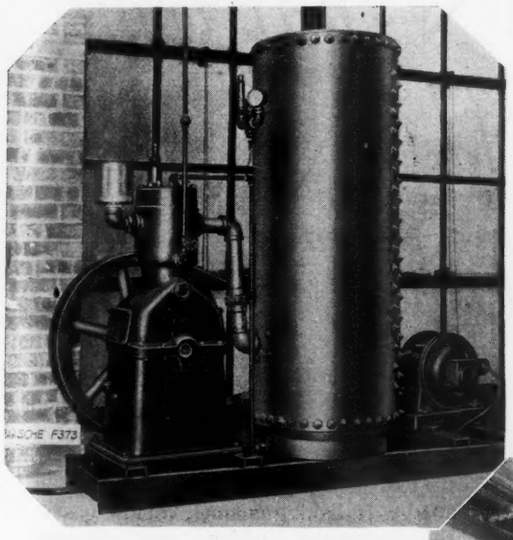
The effect of dust drawn in through the carburetor of an automotive engine is very much the same as that of dust which enters an oil engine. In the former, however, the cylinders in general receive their lubrication from the oil in the crank case, therefore any dust or dirt that may contaminate this oil may be passed repeatedly over cylinder walls and other wearing surfaces to lead to more appreciable cylinder wear than would probably be encountered in oil engines where cylinders are frequently lubricated independently of main and other bearings. Experimental work on automobile engines has indicated that cylinder wear due to dirty air is a decided factor in decreasing the life of pistons, rings, valves and other wearing elements. Clean air is a necessary adjunct to efficient lubrication if long life and high efficiency is to be obtained.



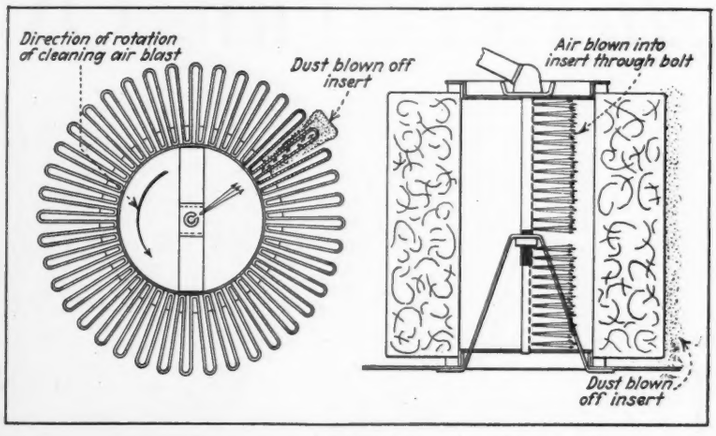
ELEVATION of a typical air filter, showing construction of metallic filtering media, locking screws, and method of locating cells in frame.



A 1,000-CUBIC FOOT per minute upright air filter, showing details of felt filter construction and manner of installing inserts.



WHERE AIR is to be used as an accessory in industry such as in the operation of a paint spray, freedom from abrasive foreign matter will not only protect the machinery involved, but also promote the formation of a more perfectly painted surface.


Direction of rotation of cleaning air blast
Dust blown off insert
Air blown into insert through bolt
Dust blown off insert

DETAILS of a felt air filter insert, showing method of cleaning by blowing air through from the inside to remove the dust effectively from the outer surface of the vanes.

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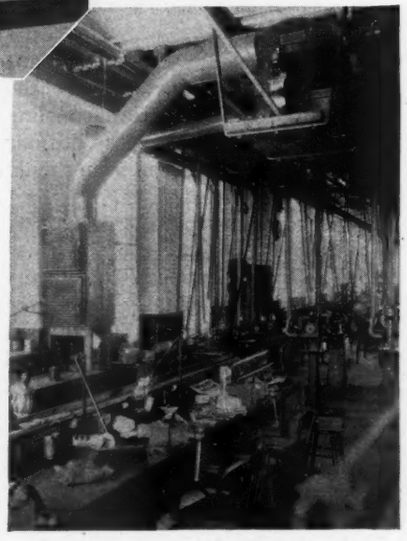
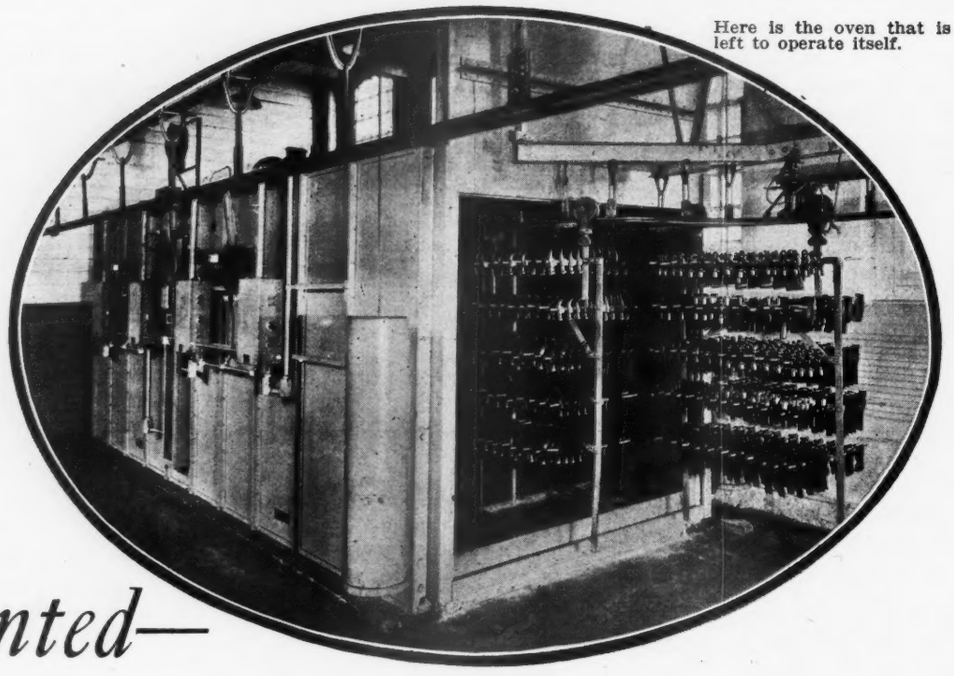


AN INDUSTRIAL air filter installation. Location with respect to blower is plainly brought out. Where grinding equipment is involved adequate purification of the air will be very beneficial.

What Causes These Belts To Wabble?

WE HAVE several leather belts ranging from 4 to 8 in. in width that continually wabble across the faces of the pulleys in a way that is not only annoying, but makes me think that something is wrong. These belts are not overloaded and are running at moderate speeds. They appear to be in good condition, and I am unable to find the cause of the trouble. Can any reader tell me what would cause them to act in this way? Other belts operating under practically identical conditions do not show any tendency to wabble. P.E.K.
Philadelphia, Pa.



Here is the oven that is left to operate itself.

Wanted—

An ELECTRIC OVEN *that would run itself!*

How Ideas and Experience Solved A Difficult Industrial Problem

By J. W. NICOLLS

Plant Superintendent, Fayette R. Plumb, Inc., Philadelphia, Pa.

IN THE PRESENT day of keen competition and the universal demand for the most for the dollar, certain products have been greatly refined by manufacturers in order that they may continue to enjoy their past reputation of making the highest quality tools. Among the many improvements, enameling methods have been completely revolutionized. Where such a very large proportion of the product is in the black finish, it is felt that the manufacturer could afford to install equipment that would be a prohibitive investment to those having much less volume in this finish.

The chief items of equipment we had been using in our enameling department were two manually-controlled, gas-fired ovens. These we decided to replace with an electric oven under automatic temperature control. Standard ovens offered us for enameling were investigated, but we found none meeting our requirements. After a careful study of the problems involved we devised plans and specifications providing for the construction of an electric enameling oven designed in accordance with our own ideas of how such an oven should be built and operated.

Standardized ovens offered us had, from our standpoint, several serious defects. For instance, they were built of thin sheet metal. They were of light construction and lacking in the necessary insulation. We wanted an oven into which, to our mind, a car carrying ½ ton of metal could be backed without fear of crashing through the oven wall. (Note there are 12 cars to one charge.)

We found no standardized oven with heating insulation over 3 or 4 in. thick. We wanted insulation twice that thickness.

Practically all standard ovens brought to our attenton had numerous through bolts, or other construction features which carry off a great deal of heat. We wanted an oven devoid of any such through metal.

In baking enamel, volatile gases are generated which are dangerous. Means should be provided to carry off these gases with minimum waste of heat and maximum dependability. We wanted an oven, the operation of which could take care of this factor automatically, insuring positive disposal of these gases with minimum loss of heat, maximum safety to life and property, and total independence of the human factor.

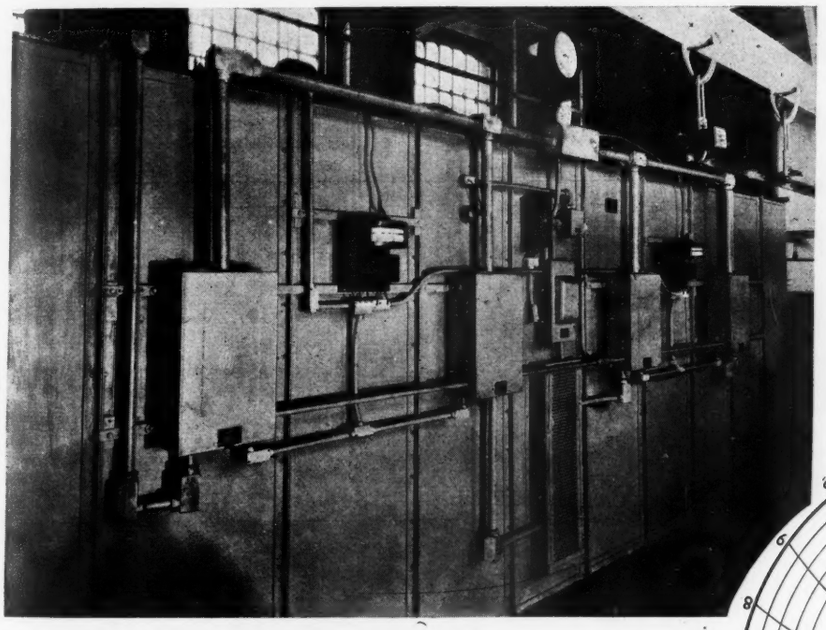
In short, we wanted an oven that would practically run itself and turn out a product of uniform quality in minimum time and at lowest cost.

That sounds like a big order, but that is the kind of enameling oven we are using today.

Built to our own designs and by us, the General Electric Company furnished heating elements and circuit

breakers and assisted us in the general layout. The secret of its efficiency is thorough insulation, and automatic control of heating elements and ventilation system. Our furnace wall, for instance, consists of 7½ in. of Silocel betweel steel plates. And not one staybolt anywhere.

The operation of our furnace begins with the closing of a time switch at a predetermined hour by means of an electric clock. The closing of this switch throws the electric current onto the heating elements within the oven. At the same time, a motor-driven blower, mounted on top of the oven, is started and begins drawing off the inflammable fumes generated from the enamel by the rising temperature. The blower causes air to



BROADSIDE VIEW of control apparatus showing location of automatic electric pyrometers. A motor-driven blower located on the top of the oven provides the necessary ventilation.

be drawn into the oven from intakes at the base. Passing through the oven the air current carries the dangerous gases through outlets at the top and bottom into a flue pipe which discharges them into the open air.

Connected to this discharge flue is other flue which, by a solenoid-operated system of dampers, the gas in the former may be diverted and led back to the bottom of the oven and so up again to the top, thus converting it into a re-circulating system.

The heating elements in the oven are divided into four electric circuits, two circuits of which are controlled respectively by one of two Brown automatic, control-type electric pyrometers. One of these pyrometers also governs the solenoid operating the dampers in the flue-pipes.

This pyrometer is set to cut off the electric current supply from half the oven heating elements as soon as the oven temperature reaches a temperature slightly below the baking temperature. At the same time turning the current into the solenoid, causing the latter simultaneously to do two important things: (*1*) close the damper in the flue-pipe leading to the outer air; (*2*) open the damper diverting the gas from the exit flue at the top back into the oven at the bottom causing recirculation. The entrance of cold air automatically ceases when this change occurs.

The idea is simple. At the start the oven temperature should be raised as quickly as posible until it reaches a temperature slightly below the baking temperature. Therefore both banks of heating elements are allowed to function until the temperature reaches that point. Current is then cut off one bank. Also, experience shows that by the time the oven temperature reaches a temperature slightly below the baking temperature the dangerous gases have ceased to be formed. Hence, the dampers are then shifted.

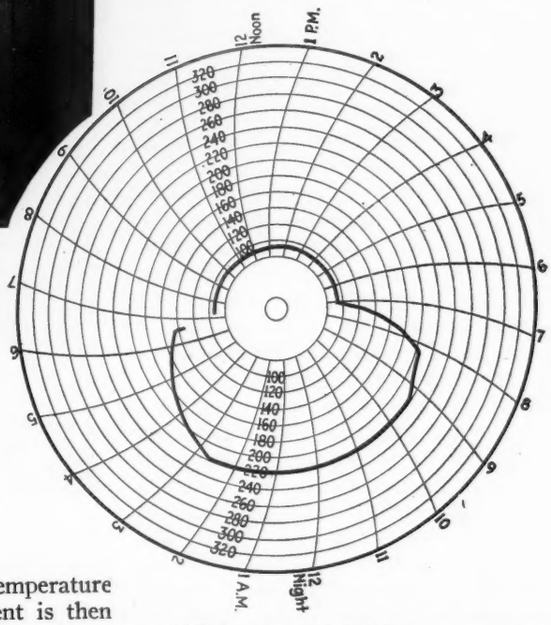
With the shifting of the dampers the oven gases, instead of being exhausted into the outer air, are continually recirculated through the oven, from bottom to top and back, at the rate of six times a minute. Instead of heat being wasted by pouring it out of doors, it is now retained in a closed circuit and a uniform temperature established and maintained by continuous heat distribution.

Following the cutting off of one bank of heating elements the oven temperature slowly rises. At baking temperature the second pyrometer automatically operates a relay, switching off the current. The temperature starts to fall. The fall is hardly begun, however, before the pyrometer switches the current back onto the heaters. So perfectly does the automatic pyrometer do its work that with no attention given the equipment whatever the temperature of the oven is held within 2½ deg. F. from the temperature it is set to maintain.

This oven has been operating regularly in our plant for six months and the entire equipment has given complete satisfaction. To summarize results, the new furnace with its automatic pyrometric control has saved us money on fuel, saved labor, reduced spoilage and generally speeded up production.

To be specific, this new equipment has reduced our cost of fuel to 2.4c. per 100 lb. of metal finished, compared to 6c. per 100 lb. with the equipment we formerly used. These figures apply only to gas and electric costs.

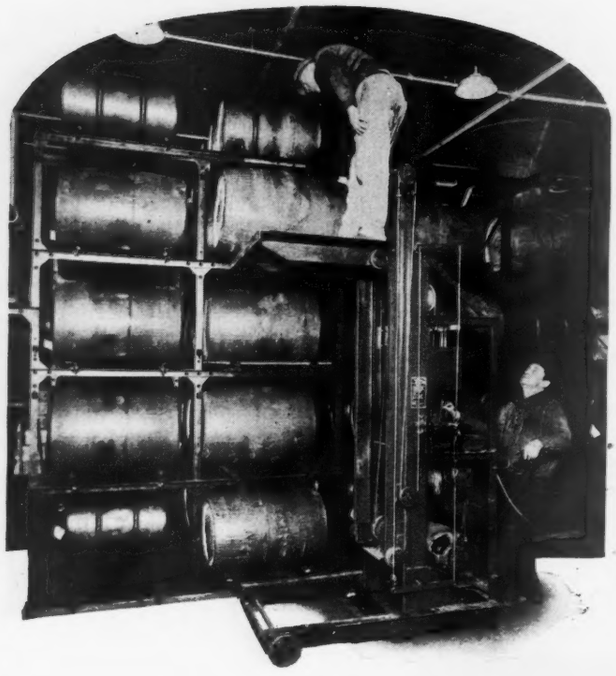
Our ideas and experience are submitted in this article with the hope that they may suggest a possible solution to industrial heating problems with which some of the readers may be contending.



TEMPERATURE CHART (not to scale) used simply to indicate the heating cycle of the oven during the night.

Are You Making

PLATFORM



THE HIGH LIFT elevating platform truck has made this type of storage rack practical, though this is only one of the scores of uses for this type of truck.

By E. J. TOURNIER

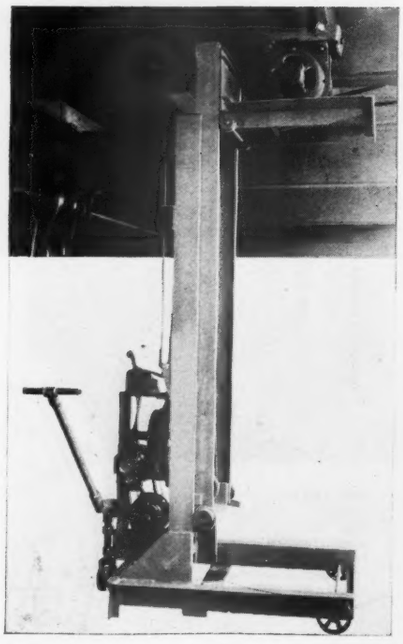
Estimate Engineer
Robins Conveying Belt Company,
New York, N. Y.

CONVEYING and elevating equipment is usually installed because it will reduce production costs, because it reduces labor turn-over, or because it reduces the hazards in dangerous work. But whatever may be the necessity for mechanical handling in a plant, the machine selected must be suited to the specific work to be done.

The functions of materials handling equipment in general may be classified into two divisions, lifting and conveying; and each division may be subdivided according as the work is intermittent or continuous. In addition to these segregations there may also be combinations of elevating and conveying.

In various manufacturing processes part of the work is continuous, and part is intermittent. In addition it is necessary to pick up loads in different parts of the plant. The units of work in these cases, are the heaviest practicable, and the loads must be conveyed, then elevated. Therefore the chief attributes of equipment for work of this character are flexibility and the ability to lift heavy loads. These qualities are both possessed by elevating platform trucks.

The use of platform trucks in warehouses for transferring and piling miscellaneous goods is a well-known application which is typical of all similar services. Carrying tote boxes, piling barrels, boxes, sewer pipe and the like are also familiar accomplishments. To enumerate such instances of single purpose, or combination uses would be practically listing the numerous industries of the United States. In each one it would be possible to show savings over hand methods, and the return of the investment in a year or less.



WHEN NOT OTHERWISE ENGAGED, this truck is called upon to act as "right-hand man" to the millwright; in this case, supporting a motor under the ceiling.

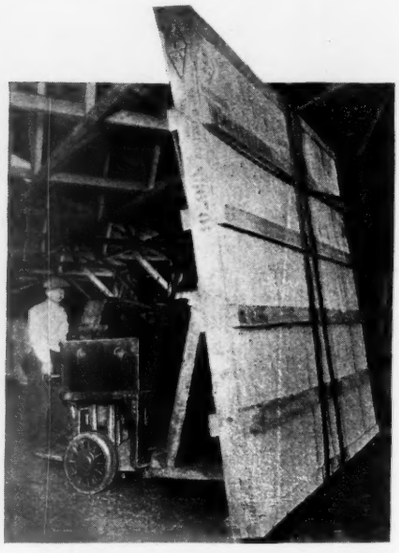
* * *

Practically every kind of industrial plant has in use some type of standard elevating truck. Its use throughout industry is in fact a well-established practice which has brought about the following benefits:

Elimination of congestion in storage areas, decreased inventories, elimination of idle time on the part of skilled workers, decreased hazard, less supervision and improved morale.

Apart from the well-known services mentioned, there are many applications in which special designs of elevating platform trucks have led to solution of problems previously thought impossible to solve.

It is possible to obtain maximum efficiency from materials handling equipment only if it is working full time under load. This is particularly true if the machine is self-powered and is accompanied by an operator, since idle time is then charged double. In most plants, however, there is little time when the truck is idle, because, even if it were intended for a single purpose, new uses are soon discovered.

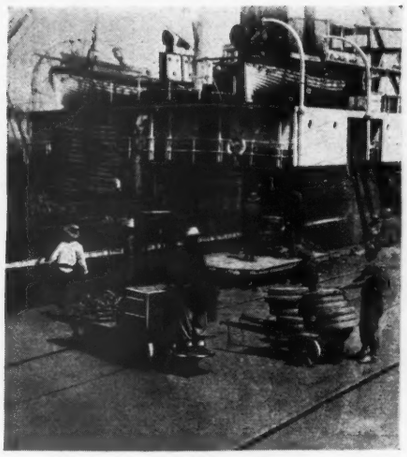


A SPECIAL DESIGN platform permits this lift truck to handle boxed plate glass with ease and dispatch.

* * *

Several plants use high lift trucks

Full Use of Your LIFT TRUCKS?



MATERIALS HANDLING equipment naturally pays bigger dividends where labor costs are high; yet here is a case of a fleet of elevating trucks earning their keep, in competition with cheap Chinese labor.

* * *

for millwright work, and each truck earns annually the equivalent of the wages of 35 men. In other plants, the truck is used by the millwright for such odd jobs as pulling cable through conduits, with block and tackle for hoisting, and with rollers or dollies under very heavy equipment for towing.

The high-lift truck has found a wide variety of uses because of its ability to carry workmen to an elevation for work on overhead shafting, on lighting equipment, for hanging motors and for work on piping.

A paper company recently installed automatic stokers for increasing boiler room efficiency, and at the same time found it necessary to arrange for the mechanical handling of coal from an outside storage to the stoker hoppers. The latter are 6 ft. above the boiler-room floor, and three boilers were to be served. The coal storage is located about 50 ft. away from the building. There is in service elsewhere in the plant, a two-ton high lift truck which it was decided to use in combination with a side-dump body for handling the coal. With the truck, three one-yard bodies and a set of skids, 30 tons of coal per day were handled, while at the same time a saving of three men in the boiler room was effected.

The savings that invariably accompany the use of the elevating platform truck are not limited to locations where the cost of labor is high. Their successful operation even in competition with coolie labor is evidence of substantial economies. In the port of Dairen, China, a fleet of trucks is used to transfer soya bean cake from steamers to storage sheds with a net saving of about $25 per day for each truck.

Certain operations in glass manufacture, in steel forging and annealing are not only slow when performed by the use of manually operated devices, but they are sometimes dangerous as well. Handling sheet tin and plate glass, also present certain elements of difficulty and risk. The service required of elevating trucks in all of these cases has resulted in special designs to meet the conditions of operation.

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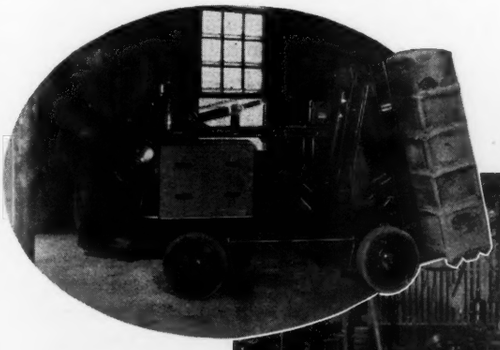
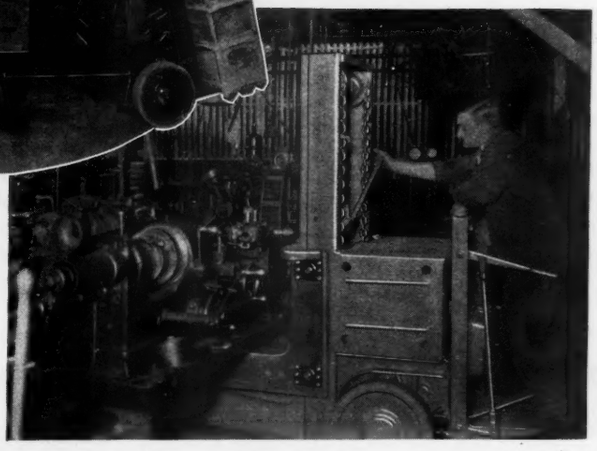


A STANDARD platform truck takes the place of the gang with pinch-bars and rollers, in changing the position of machine tools.



HERE is a special design of truck for handling boxes of pipe fittings into and out of the annealing furnace.

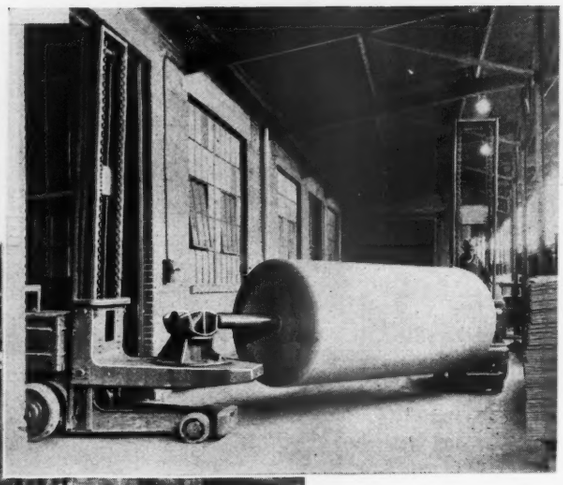
Ordinarily, an elevating truck consists of a wheeled chassis which, in addition to propelling mechanism, carries a platform which may be raised and lowered by power supplied by the truck battery. Articles to be elevated may be placed on the platform and raised to any desired height within the limits of the machine's capacity.

The special trucks mentioned are similar in all respects to the platform type, except that the platform is replaced by a ram, or a set of special arms, depending on whether the truck is to be used for annealing, randling tin plate or glass.

Turning out hot and cold rolled strip for fender stock presents a series of handling problems for which the ram truck and the crane truck have been found particularly well fitted. When hand trucks were used for moving rods of hot strip to and from the mill, and when cranes were depended upon for handling the cooled rods in and out of storage, it was impossible at times for the equipment to keep up with the job. Consequently serious congestion resulted, and sometimes men were burned or cut. Periodically the entire plant had to be shutdown to allow clearing up the accumulation of stock. The excessive amount of spillage, however, constituted a permanent loss.

The superintendent of such a plant, while open to constructive suggestions for improving the situation saw so little promise in the ram truck that he refused to permit its use. He was prevailed upon to give this equipment a trial, however. Six months later, his views had changed so radically that he stated that now the trucks could be taken out only over his dead body!

In the meantime, each of the rams had shown each month, a saving equal to its purchase price. A random load weighed when this investigation was



WHILE the service performed by these trucks in stacking rolls of news print is an everyday application, it is of more than ordinary interest on account of the high lift and heavy load.

BY MEANS of extension forks in place of the usual platform, this standard elevating platform truck handles annealing pots and takes over the job of charging the furnaces.

made, indicated that the truck was carrying 6,025 lb. of steel fender stock. Up to the time this system was installed the product from two hot strip mills had been handled by four gangs of three men each. This force was reduced to light men.

In most glass plants, clay pots are used for holding the charge in the melting furnace. Many glass manufacturers have found it advantageous to utilize the electric lift truck in handling these pots to the drying floors and later to the melting furnaces.

The newer process of continuous melt is employing both tiering trucks and a special ladle truck. For ladling the molten glass from the furnace to the drawing kiln a ladle truck having three motions in addition to travel, has been designed. The carriage supporting the ladle rotates; the ladle also rotates and tilts. Each motion is provided with limit stops, so that the operations are absolutely controlled. The speed of operation is such that the truck will pick up a ladle full of glass from the furnace and place it in the drawing kiln pot 18 ft. away in 30 sec.

Sheet glass is handled on an A-frame skid. This is made from angle iron, with wooden strips against which the glass rests.

A malleable iron foundry in Pennsylvania has a production of 250 tons of malleable daily from 7 furnaces. The material charge for the melting furnace, with the exception of coal has to be moved from storage located at various points about the plant. The castings, after cleaning and chipping have to be moved to the annealing furnace after having been packed in annealing pots. From the packing stools the pots have to be moved into the furnaces, out again to the dumping floor, and then the pots have to be returned to the stools.

In the foundry in question four furnace charging trucks are used. These trucks are of the same general design as standard elevating units, with the exception of the platform. The latter is replaced by a pair of forks on which the pots are placed.

The four furnace chargers pick up, haul and place, an average of 2,500 tons of the material every 24 hr. In a test run, the results of which have been verified by the chief engineer of the plant, two operators with two of these trucks moved 900 stacks of pots weighing 3,300 lb. each. Of this number, 480 stacks were transferred 300 ft. and 420 stacks were delivered a distance of 80 ft. in 5 hr. The cost for power for the two trucks was $2 per day.

Most of the mechanical and electrical devices used in motion picture work have as their principal function, the creation of illusion. In some cases, however, a strictly utilitarian purpose must be served.

For example, in filming a production entitled "The Wedding March," a well-known director found that he could not obtain a perspective view of the large numbers of soldiers, musicians, horses and all the paraphernalia of a military pageant from his ordinary station on the ground. Moreover, if an elevated platform were built, it would be fixed in one position and would be useless in reaching quickly, different parts of the "set."

The suggestion of a property man that an elevating platform truck would not only give the desired elevation, but was instantly movable under its own power solved the problem.

From malleable iron to motion pictures there is all the difference between make-believe and reality; nevertheless platform trucks serve equally well in making iron or in "elevating the movies."

AN APPRECIABLE SAVING in heat is effected because of the speed with which this truck is able to charge the annealing furnace.

THIS SHOWS how the annealing furnace charging truck places the pots. Another view shows the special fork extension which makes this feasible.

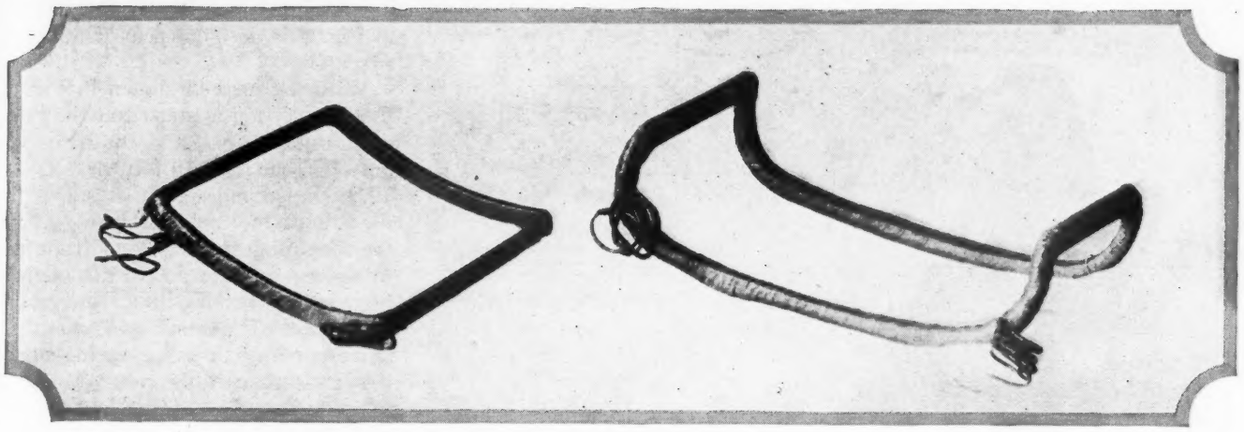


Fig. 1—A bent and straight coil used in concentric chain windings for open-slot machines

CONCENTRIC CHAIN WINDINGS *for* Open-Slot Machines

BY A. C. ROE

Renewal Parts Engineering Department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

THE two preceding articles, in the June and July issues, dealt with the hand-wound and shove-through types of concentric chain windings, the latter being an improvement over the first. It was pointed out, however, that the shove-through windings require expensive forming blocks, and considerable time and labor to close up the open ends after installing the coils.

These factors lead to the use of open slots that permit forming and insulating the coils completely before installing them in the slots. The concentric chain winding type of coil as used in the early, open-slot machines will be described in this article.

Fig. 1 shows an open and bent coil as used in low-voltage work on small machines having open slots and using the concentric chain type of winding.

A group of two straight coils, as used in an open-slot, concentric chain winding for a high-voltage, medium-sized machine is shown in Fig. 2. Each coil has 36 turns and is wound in two sections, each section having 18 turns. One section is wound directly on top of the other. Note how the starting and finishing leads are both brought out on the side of the coil. The reason and method of doing this will be explained later.

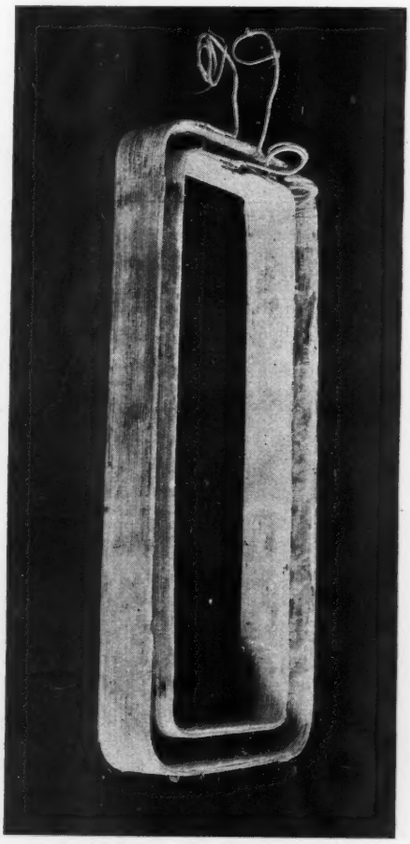


FIG. 2—GROUP of straight coils for an open-slot concentric chain winding. Each coil has 36 turns and is wound in two sections of 18 turns each.

In Fig. 3 is shown the type of mold used to wind the open-slot concentric chain winding coils of the type shown in Fig. 2. Each mold is constructed so that two different-shaped coils may be wound on it—one straight and one bent coil. For windings requiring four different-sized coils, i.e. two bent and two straight, there will be two molds. Three molds will be needed for six coils, four molds for eight coils, and so on.

The straight coil is being wound in Fig. 3, the wire passing straight around the ends of the mold. This illustration shows a start-on-right coil; that is, the starting lead is brought out on the right-hand side of the mold, as shown at the lower right-hand corner. The turns are put on in the first section from right to left. A cambric cell is used in the slot section to hold the wires in the proper formation.

Fig. 4 shows how the mold of Fig. 3 is used to wind a bent coil. The

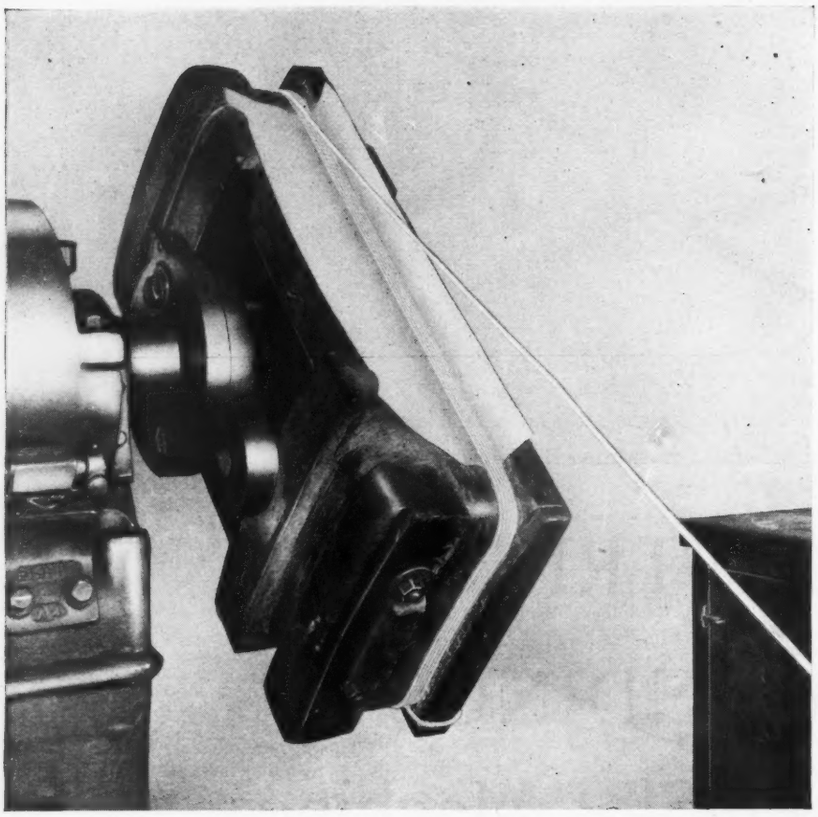


FIG. 3—THIS IS THE TYPE of mold used in winding the open-slot type of concentric chain coils. Each mold is used to wind one straight and one bent coil. The coil being wound here is the large, straight coil shown in Fig. 2.

* * * *

bent coils are started on the left so that the turns are built up from left to right. This is necessary in order that the wires may be built up around the bends from the inside out; that is, the smaller-radius bends are made first.

In Fig. 4 the start of the second section is shown; the first section of 18 turns has been wound on the mold and heavy cotton drilling cemented over it as shown. Then, to start the second section, the wire is bent down from the top of the mold at the bent end, to the bottom of the mold, as shown at the lower left of Fig. 4. This is termed a crossover. The reason for making it will be explained later.

The first and last turns of each section are reinforced with tape. As there is a higher difference of potential at these points, and these turns are on the outer and inner edges of the coil, there is more chance for short circuits to occur unless the turns are well insulated.

Figs. 5 and 6 indicate the two methods that can be used to wind the coils shown in Figs. 2, 3 and 4. The plan followed in Fig. 5 is called winding straight up, whereas that shown in Fig. 6 is designated as winding in two halves.

With the method shown in Fig. 5, the first section is started at the right of the mold, or *1*, and the turns are put on from right to left, or *1* to *18*. Then the second section is started at the left of the mold, or turn *19*, and the remaining turns put on from left to right, or *19* to *36*. This method of winding results in an increasing difference of potential between the corresponding turns of each section, the maximum difference occurring between the start of the first section and the end of the second section. The difference in potential tapers off to a minimum between the end of the first section and the start of the second section.

The difference between any two corresponding points is indicated by the figures at the right in Fig. 5. Thus, the figures indicate that between turns *7* of the first section and 30 of the second section, there is a difference of 23 turns, or 23 times the volt per turn will give the difference of potential at this point.

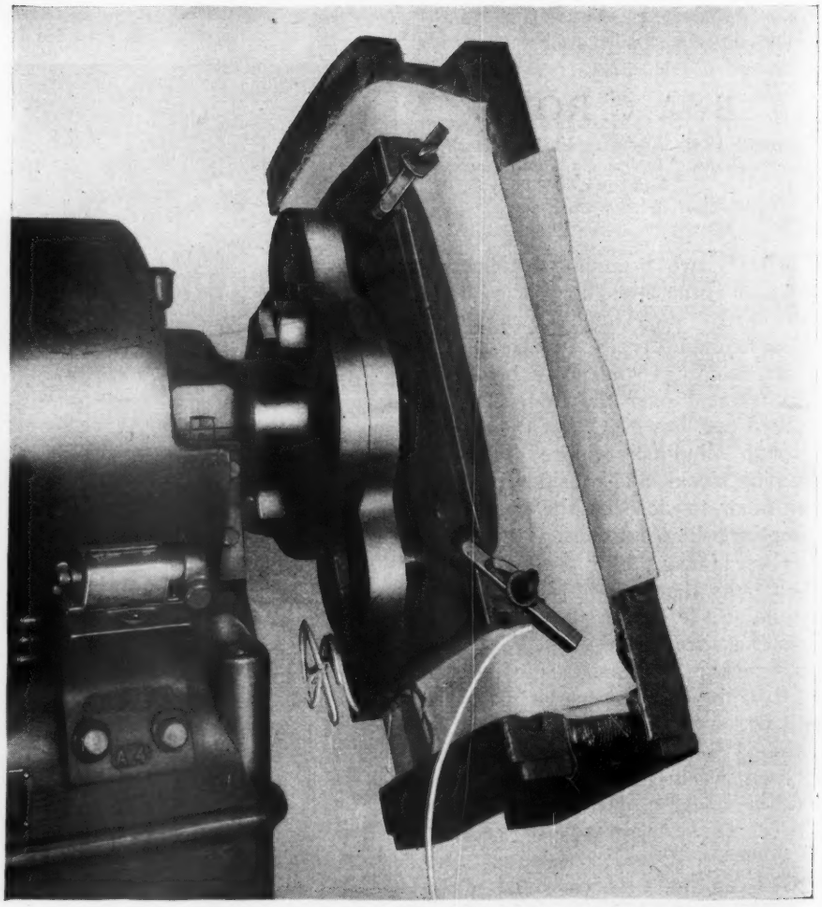


FIG. 4—HERE THE MOLD SHOWN in Fig. 3 is being used to wind a bent coil. Note how the ends of the coil make a 90-deg. bend out and down the side of the mold, giving rise to the term "bent coil."

Thus a coil wound as shown in Fig. 6 would require sufficient insulation between sections to stand the maximum difference of potential at the point between the start of the first section and the end of the second section, so turns *1* and *36* would have to be well insulated.

Fig. 6 illustrates how winding the coils as per Fig. 4, or in two halves, results in a uniform and lower difference of potential between any two corresponding turns of the first and second sections. With this plan the first section is wound from right to left; then, to start the second section, the wire is brought back across the mold to the right and the second section is also wound on from right to left, resulting in a difference of 18 turns across the sections. The first and last turns of each section and the crossovers can be well insulated, and in any event the stresses are lower.

In Fig. 2, the leads are shown brought out on the same, or right-hand, side of the coil. To do this, the finishing lead of the second section is brought back across the coil in the same manner as the crossover shown in Fig. 6. This brings the coil leads in the proper location for connecting up the coils per pole phase group.

After winding, the coils are given a varnish treatment or impregnated with gum by the vacuum-and-pressure method. The treatments given vary according to the voltage, and other service conditions.

The coils are completely insulated, using mica and fish-paper wrappers in the slot section and treated cloth or mica tape on the ends. The number of layers vary according to the line voltage and the operating conditions, as does also the final varnish treatment given the finished coil.

The open-slot concentric chain winding coils are an improvement over the hand-wound or shove-through types, but they are still inferior to the present-day two-layer, diamond-shaped coil for the following reasons:

1. A chain winding cannot be reconnected from two to three phase, or *vice versa,* as the mechanical arrangement of the coils prevents proper grouping.

2. The coil pitch is dependent on the number of slots per pole per phase; therefore, chording cannot be resorted to at the will of the engineer.

3. A number of molds are required, making replacement parts expensive.

4. Due to the shape of the coil, an excess length of copper is used; thus, the losses are high as compared with a two-layer coil. In one case 600 lb. of copper was saved in changing over a 1,400-hp. motor.

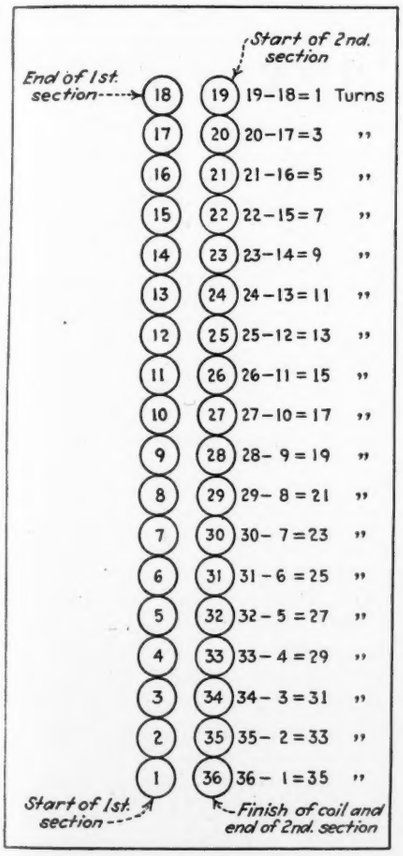


FIG. 5—WHEN A COIL is wound straight up, it is formed like this. The first section is started at *1*; the second section starts at *19* and ends at *36*. The difference of potential between turns increases with each turn and reaches a maximum between the start of the first section and the end of the second. The figures at the right of the turns, when multiplied by the volts per turn will give the difference of potential at the corresponding points.

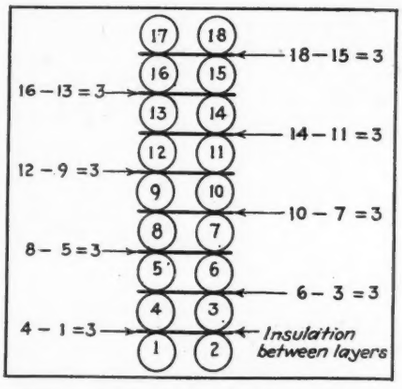


FIG. 6—WINDING COILS in halves gives a lower difference of potential between the turns of the first and second sections. The first section, starting at *1*, ends at *18*; then the wire is brought back to *19* and the second section wound, ending at *36*. It will be seen that there is a constant difference of eighteen turns across the sections.

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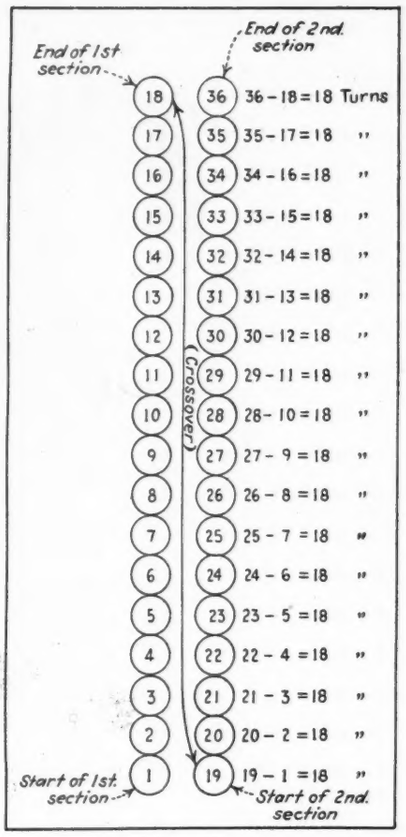


FIG. 7—IN THE TWO-LAYER COIL the turns per coil are reduced one-half. Note that this method of winding results in a lower difference of potential between layers. The maximum difference of potential at any point will be three times the volts per turn.

* * * *

Fig. 7 shows another advantage of the two-layer coil; that is, the turns per coil are reduced one-half and the method of building up the turns and layers results in a lower difference of potential between layers. Thus, the 36-turn coil shown in Figs. 5 and 6 would be reduced to 18 turns and wound as in Fig. 7, or with 9 layers of turns per layer, which means that the volts per turn times 3 is the maximum difference of potential at any point in the coil. It is a simple matter to add extra insulation at these particular points so that the dielectric strength of the fabric will not be exceeded.

The two-layer diamond coil also has the advantage that it can be made on adjustable shuttles and pulling machines.

The open-slot, concentric chain windings can be changed over to the two-layer diamond type at a decided saving in cost and improved operation. In fact, it is good policy to rewind such machines completely with up-to-date coils rather than replace two or more groups of the old type coils.

This type of respirator uses fly-screen as the chief filtering medium.

PROTECTING *the* WORKER *Against Dangerous Dusts*

By M. E. CLEMENTS

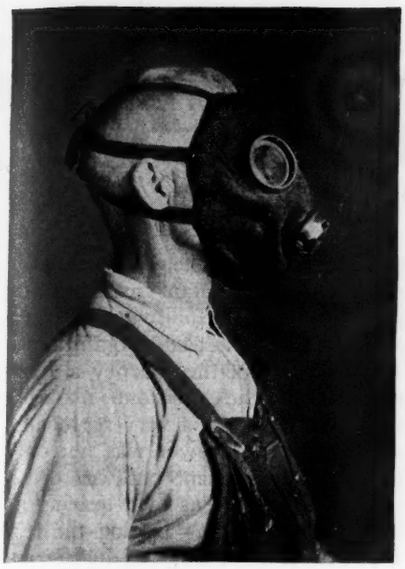
THE NUMEROUS industries in which workers perform their labor in atmospheres charged with unwholesome and poisonous dusts or gases will be interested in a device developed by the Federal Bureau of Mines, which serves all the purposes of a hat, and at the same time intercepts the dangerous dust particles that would otherwise penetrate the lungs of the wearer. When the device is worn by miners, it should tend to ease the blow of any dislodged piece of rock that might tumble down upon the head of the worker.

Poisonous dusts, such as those bearing lead or arsenic; some rock dusts, such as silica; metallic dusts, including those produced in grinding and polishing shops; and many other dusts, including some organic dusts such as those in textile mills, are injurious when constantly breathed. Hard-rock miners, stonecutters, glass-workers, potters and metal grinders are especially exposed to the dust hazard. Dusty atmospheres are occasionally encountered by everyone, and discomfort is experienced, even if no special harm is suffered.

Any dust inhaled into the respiratory passages or lungs can be considered harmful, even if it is not especially dangerous, the Bureau of Mines investigators point out. The body has a limited capacity for removing dust particles, but when this capacity is exceeded the lungs become gradually charged with the dusts. As much as thirteen grams of silica rock dust, numbering twenty million millions of particle, have been found in the lungs of miners who died from silicosis. Most of these particles of dust were about one micron, or one twenty-five thousandth of an inch in diameter. Only a powerful microscope can make such particles visible to the eye. About fifty placed in line would be needed to equal the diameter of a human hair. When such very small particles are dispersed in the air, they are carried about like smoke, and they settle very slowly from quiet air.

A HOME-MADE RESPIRATOR of cheesecloth, which has been used to advantage in the white lead and similar industries.

In the type of dust respirator devised by the Bureau of Mines chemists, a filter is built into a square brimless hat or cap, a rubber tube connecting the cap with the nose cover. As the wearer breathes, the inspired air passes first through the



THE MAN with this pig-like face covering relies upon felt as a dust-catcher.

* * * *

outer filtering material to the interior of the cap, then through a mica-disc check-valve in the top of the cap, then through the tube to the nose cap. The mica-disc check-valve prevents back flow of exhaled air. The cap filter is built on a wire frame which is lined up with fabrikoid, to prevent dusty air being drawn over the wearer's scalp and hair. Canton flannel, which has less tendency to clog with deposited dust than most materials, is the chief filtering material employed. Between the linings of the cap is a filler about one inch thick of sterilized curled hair like that used by upholsterers.

The entire respirator weighs 21 or 22 ounces. The weight is balanced on the head and is not oppressive, because the head is free to move in any direction. In order to avoid the discomfort caused when the face is covered, the part touching the face has been reduced to a minimum. The mouth is uncovered, so that the wearer may talk freely.

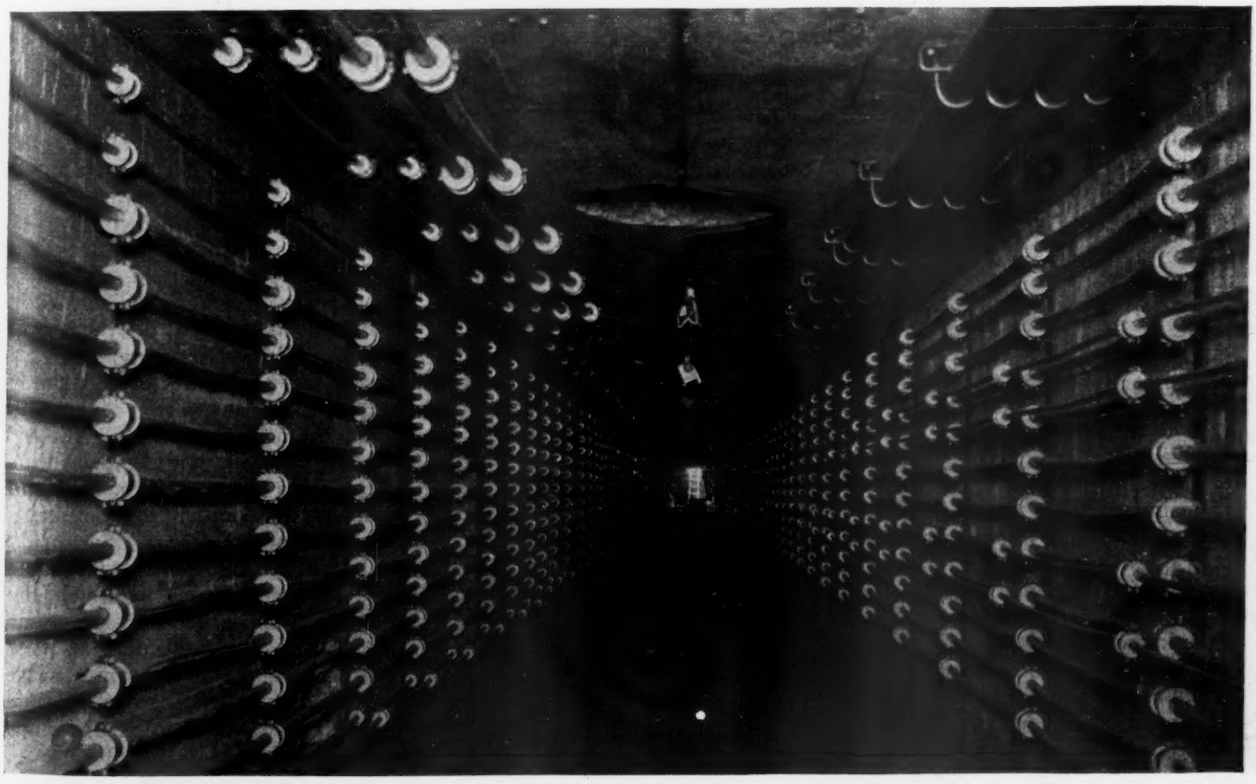
In the progress of its investigations the bureau found that a great variety of queer-looking contrivances was being employed for the purpose of combatting unwholesome dusts. In some types of respirators, wet sponges are depended upon to catch the unwelcome dust particles. Paper, made of various fibers, is the chief filtering material used in other makes. Felt and other cloths are used in still other types. Fly screen is also used. Cheesecloth respirators, made at home, have been used to advantage in the white-lead and other industries. Photographs of a few of these odd-looking contrivances are shown on these two pages.

THE TYPE OF RESPIRATOR developed by the Bureau of Mines.

* * * *

Underground Distribution at a Glance!

The problem of carrying feeders to auxiliary motors in a large electrified mill was solved in this way. The tunnel extends from the substation basement to a distribution point where the feeders branch off to their respective motors.



Plant Engineer's

COMMENTING upon the suggestion recently made in these pages as to a more suitable title for the plant engineer, Mr. McRea Parker writes as follows:

"It appears to me that the term 'Plant Engineer' is descriptive enough and it has the added advantage that it has been officially recognized in some localities, notably in the New England States where there is an association of plant engineers and, locally, in Cleveland by the Cleveland Engineering Society where there is a 'Plant Engineers' Division.' While the term 'Industrial Engineer' might be more descriptive and all embracing it has unfortunately been adopted, as you say, by so-called efficiency engineers and other consultants dealing in industrial problems.

"In this connection, I think we should distinguish between master mechanic, chief engineer, mechanical superintendent, and plant engineer, as you have listed them. From my observation, a chief engineer is generally the man who is responsible for the design of the product where the product manufactured is of a nature permitting engineering design; the plant engineer has to do with the problems involving the land, buildings and equipment—furnishing the means of production; the mechanical superintendent, I take it, is a designation parallel to that of plant engineer;

and master mechanic covers a practical man who is directly in charge of the shop force and responsible for maintenance.

"It might prove interesting to get out a questionnaire, to be sent to a number of representative industries —this to be filled out by someone in the know, giving the various titles used and outlining the responsibilities pertaining to each title."

Mr. Parker's views are sincerely appreciated, as a decidedly worthwhile contribution to the discussion. We should have many more expressions on this subject in order to get the opinion of the profession as a whole.

In reading over some old correspondence, I came across another title which neither Mr. Parker nor I had mentioned. It was the very dignified title of "Supervising and Consulting Engineer." It is descriptive, to a degree, but perhaps a bit clumsy.

* * * *

Referring to material in the Forum for July, Mr. R. R. Schellenger writes:

"I note you ask for suggestions on the prevention of corrosion on sheet iron plates.

"I am wondering if it would not be feasible to use a coating of chromium, electrically deposited. This would not only prevent corrosion but would give a hard and smooth surface that might be of value in Mr. Hopkin's process work. True, this would be an expensive remedy, but from my point of view, it appears that it would be economical in the long run, when the great durability of such a coating is considered."

As Mr. Schellenger says, chromium plating would give a hard, smooth surface, but it is usually necessary to plate it over nickel. While it might spot less readily than nickel plating, it is doubtful if it would resist corrosion any more effectively. Also, these two platings are hard and apt to chip if there is much handling of the plates. Under such conditions the softer coatings such as galvanizing and zinc plating might last longer. The comparative costs are about as follows: hot galvanizing, $1.60; zinc plating, $2.10; nickel plating, $3.15; chromium plating, $3.50; non-corrosive steel plates, $7 to $8. Mr. Hopkins might try some of each, and determine which gives the greatest length of service per dollar.

* * * *

Recently I had occasion to visit the plant of a manufacturing company to complain of poor workmanship in equipment purchased from them and was taken through the plant by the assistant manager for the purpose of exhibiting the excellence of their plant and organization. At one point in the journey a foreman asked the assistant manager what seemed to be a very reasonable question. The answer was not only terse and insufficient but was delivered in a manner as over-bearing as could be imagined. During the trip I saw several instances of indifferent workmanship and suspected the cause of it. Later on I commented on the fact that he seemed to have discipline and he replied, "Oh, yes. You are either boss or you are not."

Workmen do not produce their best work unless they have some interest and pleasure in their occupation.

The executive who accomplishes the most is one who has his men running toward instead of away from him.

There are times when the high privates in the rear ranks seem to know just about as much as the colonel. Billy Addison, who has just come up from the South on a visit, tells of the docks superintendent of a Southern Company which pays its stevedores less than the market wage. This superintendent told a colored stevedore to hustle a bit. The darkey looked meditatively at his boss and drawled: "Boss—you's payin' 35c. an hour and you's gettin' just 35c. worth o' work."

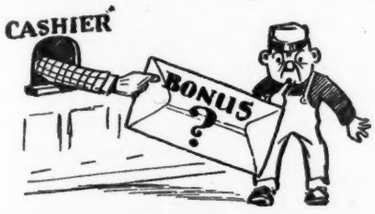
* * * *

A large corporation has under consideration at the present moment the payment of bonuses to the maintenance crew. If they decide to do so it will be interesting to see the plan as ordered and to watch the results. It appears to be a hazardous undertaking. To my mind the most difficult item is to determine what part of the maintenance is chargeable to the crew because of the various conditions that affect maintenance.

's Forum

The type of person operating the equipment and the supervisor in charge of them have a great deal to do with maintenance costs. Sometimes they are considerate of the equipment and sometimes they are not. Frequently there is a large turnover of labor in one department and maintenance costs rise. Also the rate of production has its effect upon the amount of maintenance required. These influences are independent of any act of the crew. For these reasons the crews may receive premiums or penalties for which they are not responsible and such a condition always means dissatisfaction. The monthly maintenance costs in any one department may vary greatly from one month to another and in such a case it would be necessary to assume a long time average. This would probably result in a yearly average and if the bonus were not large the crew would lose interest.

Another possible bad effect would be that it would have a tendency to let minor repairs slide and make major repairs more frequent. A piece of equipment if kept in the best



of condition might last 5 years before requiring a general overhauling but if minor repairs are not maintained the overhauling may be necessary at the end of 3 years.

It is just the same proposition as accident prevention. Rewards are offered for the least number of lost-time accidents but never for the least number of minor treatments at the dispensary, because everyone knows that under such a drive the employees would not report minor injuries which often result in infection or other serious consequences and the number of lost-time accidents would increase.

There is one condition under which maintenance bonus payments might be feasible. A rubber manufacturing concern in Massachusetts put certain departments, when life work was purely mechanical, under the supervision of the industrial engineer. Having control of the production crew, the engineer should be able to secure the type of operation that would result in reasonable maintenance. Perhaps a better plan would be to offer cash prizes for suggestions to reduce maintenance costs. There may be certain local conditions in some plants where bonus payments to the maintenance crew would be practicable, but as a general principle it does not appeal to me. Perhaps some of the Forum readers have had experience or have some suggestions. If they have it would certainly be interesting to hear from them.

* * * *

Industrial engineers are affected by many state and municipal laws relating to public safety and health and yet have had a negligible part in framing them. In one state last year it was discovered that 95 per cent of the bills before the legislature were for modification of present laws. There were 12 bills relating to one branch of public safety, all from different interests fighting from different angles.

An act of the legislature should do no more than to create a department for enforcement and to give that department authority to act. For that department there should be a code of rules and regulations formulated by a board consisting of representatives of the various interests involved. For instance, the code relating to fire prevention would be drawn by a board containing a representative of the state department enforcing the law, the board of under-writers, the fire chiefs association, the owners through some chamber of commerce or some other body, the engineering societies and a member of the legal profession preferably a senator. This body would act as a board of appeal.

If such a group of interests would combine to draw up new laws they would represent a total strength and such unified effort that the new law would probably be passed and the necessity for amending it would seldom occur. It would cut down the great mass of bills that appear annually before the state legislatures. The one representative who could start such a movement with the altruistic motives and therefore not be charged with selfish interests is that of the engineers. And who is a better all around authority on the limitations of laws relating to fire prevention, building laws, boiler codes, engineers licenses, sanitation, accident prevention and other codes of this nature through the industrial engineer?

At first glance this proposition appears as an idealistic dream too big to be accomplished. Study the problems and discuss with the leaders of the interests mentioned and you will find that it is not beyond the pale of possibility. The engineer should do constructive work in civic affairs and in what way can he give more competent aid than in a proposition like this?

* * * *

"Bob" Jackson is a contractor of many years experience and has often solved problems without the aid of engineering science. He recently had a contract to place a flat bottom steel tank 30 feet square in the corner of a room and on the floor. His foreman in charge of the work moved the tank into the corner of the room, raised it on jacks and took out the blocking but could not scheme a way of removing the jacks. He telephoned to "Bob" who arrived in a half hour with a truck load of ice. The cakes of ice were placed under the tank, the jacks were lowered and

removed. As the ice melted the tank settled into position. Of course all cakes of ice do not melt at the same rate, but a torch applied to the bottom of the tank over the slow melting cakes took care of that. Soon the tank was in a tight corner and "Bob" was out of it.

Quarterly and semi-annual budgets for maintenance and repairs are now in operation for another period and it might be well to give advance consideration to the next budget. It is customary to charge the monthly cost of maintenance and repairs against the cost of production of the month in which they occur. This, of course, is essential for the treasurer but it is not satisfactory for comparing acual monthly costs of production. After 5 years' operation, a major piece of equipment is given an expensive overhauling and, if it is accomplished in a particular month, the cost is added to the cost of production of that month. Actually, that cost of repair should be charged against the production of the 5 year period.

It is argued that these major repairs will average about the same each month, which is often the case, but it does not solve the problem of its effect upon the monthly unit cost of production. Each month the unit cost of production is figured by the cost accounting division and sent to the management with comparisons of previous costs. If the unit cost is high, the management will increase its efforts to reduce the unit cost in the succeeding months. If the plant is running full, it will be difficult to release equipment for major repairs and the cost of repairs for that month will be small, which, spread over a large production, will give a lower unit cost of production.

The logical time for major repairs is when the production is small. This means that a large repair cost spread over a small production will increase the monthly unit cost of production.

Would it not be feasible to carry the cost of maintenance and repairs as an overhead charge at a practically constant unit cost? This charge could be determined by estimating a year's production and a year's repair cost. The estimated unit cost would be fairly close and could be adjusted toward the end of the year to bring it in accordance with actual costs. This would cause some variation but the variation would be much smaller than it is with the present system. Has anyone a better method of handling these changes?

* * * *

"While reading your interesting articles in the June issue of INDUSTRIAL ENGINEERING," writes Mr. Geo. W. Harris, "I was especially interested in Mr. Henry Tock's success in developing a system of scheduling production in the various departments, which resulted in the factory making shipments on scheduled time.

"We have a similar problem and I would very much appreciate any information you might obtain for me regarding Mr. Tock's system."

Since a comprehensive reply would be impossible in the space available here, Mr. Harris' inquiry is being answered by correspondence.

What Keeps the "Little Fellow" Going?

By DONALD A. HAMPSON

Plant Superintendent, Morgans & Wilcox Manufacturing Company, Middletown, N. Y.

THE wiseacres come along periodically with the assertion that the small plant is doomed. And they have only to point to recent news items concerning a union of well known concerns in one line or another to give their assertion weight. However, that does not prove the case. In fact, for every concern that is taken into a consolidation, there is quite apt to be a new one started.

Small plants will always be able to get business—some of it local, some of it national in scope. The strong argument for the small plant is the personal touch it can give to its work, the "service" it can give to its customers, to use a much abused word. The big plant, on the other hand, is so vast and so bound up with red tape that it usually serves but slowly—usually, though not necessarily. It has been the writer's experience that the big electric manufacturing concerns are particularly slow in small matters.

For instance, we had a coil burn out in the starting compensator of a 7½ hp. motor not so very long ago. This was the product of one of the country's Big Three in electrics and we knew from past experience that it was almost impossible to get anything out of them in the repair part line.

We picked out the required part

from the parts list found inside the compensator case, and put it down as:

CR 1034 hand starting compensator three phase, size No. 6.
Part A1, under-voltage release coil.
With 7½ hp. induction motor, Type HC, 220 volt.
Bought 6-24-23 through Smith Electric Company.

Surely that covered everything that any manufacturer could need, to supply the part wanted? But to cover every point at our end, we had a man come in from Smith's end to verify our interpretation and we got from them the name and address of the proper department to which they, as distributors, sent for such parts. All of this was put into a special-delivery letter with our order and a request for prompt attention.

At the end of a month's waiting, we got to the breaking point and began to send telegrams collect. (There is no surer way to break red tape than to wire collect, and keep on doing it.) At the second wire, they came back with the reply that we hadn't given them sufficient information to fill the order.

Accordingly, we duplicated the original information—nothing else—and the coil was with us in a week's time.

That has been the writer's invariable experience when dealing with the big electric companies. Of course, it is not necessary; it seems that there is an indifference to small orders which amounts to condescension before they are filled. Meanwhile, the poor victim gets more and more disgusted and vows that he will purchase from the little manufacturers when in the market again.

QUESTIONS *Asked and Answered* *By Readers*

HERE IS A PLACE *where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience*

Size of Equalizer Required Between Generators

As a temporary installation while our large generator is being overhauled, I wish to connect a 250-volt, 300-kw. over-compound d.c. generator to a distribution bus fed by a 250-kw. and a 100-kw. d.c. 250-volt generator. Both of these latter generators are flat compounded. Four 800,000 circ. mil cables 1,000 ft. long and connected two in parallel will tie the 300-kw. generator to the board. I shall appreciate it if readers will tell me what is the smallest size of equalizer that I can use with satisfactory results. O.L.A.
Manitowoc, Wis.

* * * *

Use of Electric Heat in Silver Soldering

In our plant there are several rotary converters on which the damper windings are loose. We brazed one, but this process requires too much time; we cannot keep these machines out of service long enough to braze all of them. I should like to know whether any reader has tried silver soldering with electric heat, applied either by an arc or otherwise. If so, please give me the details of how it was done.
Fairmont, W. Va. R.M.S.

* * * *

Will New Brush-Holders Keep These Machines From Sparking?

We have four old Western Electric, 400-kw., 110-r.p.m., 250-volt generators using radial box-type brush-holders.

These machines were originally designed for 125-volt operation, but five years ago were rewound for 250 volts, and the thickness of the brushes cut in half. We have tried five or six different grades of brushes, but have not found one that is entirely satisfactory, as they all spark, cut the commutator or are noisy. The brushes used measure ½ in. x 2 in. x 9 in. long. The commutators are undercut and slightly out of true, and I am wondering whether reaction-type brush-holders will clear up this trouble, but do not want to go to the expense of installing them unless it is necessary. I wish that readers would give me the benefit of their experience in solving problems of this sort.
Bloomfield, N. J. H.F.K.

* * * *

Method of Filling Holes in Laminations

Will some one please tell me the best way to fill holes that are blown by grounds in the laminations of rotors and stators? C.L.K.
Springfield, Ill.

* * * *

Accuracy of Tachometer and Revolution Counter

Will readers please tell me of their experience in the use of hand tachometers as compared with the well-known revolution counter and stop watch? I want to compare the accuracy of the two methods, and also find out whether any tests have been made to determine the errors due to the human equation when using the revolution counter and stop watch. W.T.C.
Jersey City, N. J.

* * * *

How Many Maintenance Men and Why?

Our maintenance department has been criticised for having what is considered to be too many men. For example, it requires the full time of three men to service about 200 motors, totaling 1,785 hp., and their attendant equipment. But it seems as though two men should be able to do this work. I do not want to mention the nature of our product, but I wish that readers in every industry from metal working to food products, would advise me just what their yardstick is for determining the number of maintenance men required for their plants. Is it based on the horsepower of the motors, on the number of motors and machines, or on the quantity of the product handled? S.Y.K.
Bridgeport, Conn.

* * * *

What Is Causing Trouble With This Commutator?

We are having trouble with the brushes and commutator on a 125-kw. Crocker-Wheeler direct-connected generator installed a year ago. About once a week a black spot appears on the commutator, and the mica sticks up above the bars as though something were eating the copper away. I have turned the commutator down twice, and use a commutator stone each week to cut the mica down even with the bars, but this gives only temporary relief. I have also tried using vaseline on the commutator and boiling the brushes in vaseline, as they chatter very badly at times and wear rapidly. I shall be grateful for suggestions from readers as to how this trouble may be cured. E.R.
Keltys, Tex.

* * * *

Can Formation of Static on Belts Be Prevented?

I should like to know if leather belts can be treated to prevent the formation of static electricity. Grounding by means of a comb or collector will drain off the charge, but I should like to prevent its formation, if possible. When belts are operating in the presence of explosive dust or fumes, I feel that there is always a chance of the discharge between the belt and a comb causing an explosion. If anyone has solved this problem, I shall be grateful for the details.
Chicago, Ill. L.C.W.

ANSWERS *Received to Questions Asked*

Winding Data for Old Induction Motor

Can any reader give me the winding data for an old G.E., Type KQ, three-phase, 220-volt, 10-hp., 1,800 r.p.m. motor? There are 48 stator slots which are large enough to accommodate 40 No. 14 wires with insulation. The bore is 8 in.; the core is 4½ in. thick, and there is 1¼ in. of iron below the slot. The slots are 1¼ in. deep. I want to wind this motor to deliver 10 hp. at 1,800 r.p.m. 220 volts, three-phase, 60 cycles.
Cape Girardeau, Mo. L.W.

REFERRING to the inquiry of L. W. in the August issue, I note that he refers to a General Electric type KQ, three-phase, 220-volt, 10-hp., 1,800-r.p.m. motor.

There is evidently something wrong here because the nomenclature KQ means quarter phase. The letter Q stands for quarter phase. If this were a three-phase, squirrel-cage motor, it would be KT. It is my suggestion that L. W. take the serial number from the nameplate together with the full motor rating and send same to the General Electric Company, Schenectady, N. Y. If the nameplate has been lost, the serial number will be found stamped elsewhere on the motor.

In such cases it is always better to give too much information rather than too little, so that if more than one number is stamped on the motor, give both of them. With this information, the whole question can be referred to the designing engineers who, in turn, will refer to the original design on this motor and give authentic information regarding its rewinding and whether or not it is feasible to change the winding from two-phase to three-phase and maintain the desired speed, horsepower and voltage.

Such changes are not always easy, or even possible, to make.
Scotia, New York. E. F. ROGERS.

REPLYING to L.W., the following data figured from the core dimensions given may be used to wind a 60-cycle, three-phase, 1,800-r.p.m. motor capable of developing 10 hp. at 220 volts, and drawing approximately 25 amp., which is the normal rating for this motor.

Using a two-layer winding, there will be 48 coils, 1 & 10 span, 4 coils per pole phase group, with 40 single turns of wire. The connection being four-circuit delta, use No. 17 single cotton enamel wire, or if L.W. prefers, he may wind the coils with 20 turns, 2 wires connected two-circuit delta using the same size wire.

There should be room in the slots for this number and size of wire since No. 17 is one-half the circular mil area of No. 14. If there should be enough room in the slots, No. 16 magnet wire could be used, thereby making a more efficient motor. L. C. ANDERSON.
Marshalltown, Iowa.

THE designation KQ applied to L.W.'s motor indicates that it was originally designed for two-phase operation, but it can be satisfactorily rewound for three phase.

From the data given it appears that the following winding should be satisfactory: The coils should be wound with twenty turns of No. 15 single- or double-cotton-covered, enameled wire. Place the coils in slots 1 and 10, etc., which will give approximately 75 per cent pitch. The winding should be connected two-circuit delta.

In my opinion making the coils of No. 14 wire would crowd the slots somewhat, but by careful workmanship it is possible that this size of wire could be used without damaging the insulation, and slightly better results would be secured. V. S. FOSTER.
Induction Motor Engineer,
Canadian General Electric Company, Ltd.,
Peterboro, Ont., Canada.

Locating Short-Circuited Coils in A.C. Motors

I shall appreciate it very much if readers will describe what they consider to be the simplest and best method of testing and locating short-circuited coils in three-phase, squirrel-cage induction motors.
Cleveland, Ohio. N.T.B.

ANSWERING N.T.B., in my opinion the simplest and quickest method of testing short-circuited coils in three-phase induction motors is by means of a growler.

A short-circuited coil in a running motor causes a humming noise, a reduction in speed below normal and excessive heating of the defective coil, or coils. Unless the current is cut off promptly, the short-circuited coil will roast out and probably damage adjacent coils at the same time.

Where a short circuit occurs in a stator coil while running, the defective coil can usually be located by feeling, as it will be hotter than the others, if the windings can be examined before they have had a chance to cool. Also, the appearance of the defective coil will be different from the others on account of the excessive heating.

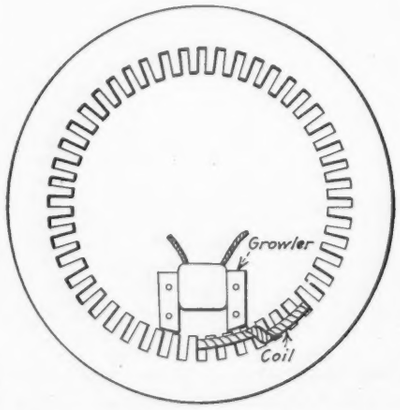


FIG. 1—METHOD of using a growler to locate short-circuited coils in a stator.

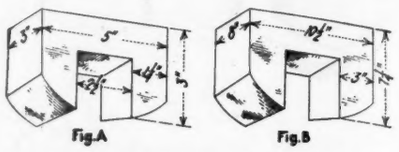


FIG. 2—THE DIMENSIONS of the growler shown in Fig. 1 are given in *A*. Sketch *B* shows the dimensions of a growler for use on larger motors.

To locate a short circuited coil with the growler, the rotor is removed, the growler is placed in contact with the inner periphery of the stator, alternating current of suitable voltage is applied to the growler winding, and it is then slowly moved around the bore of the stator. If the growler passes over a short-circuited coil, or one in which some of the turns are short circuited, it will emit a different hum and the defective coil can be detected by feel, as it will immediately heat up. If an ammeter is placed in the growler circuit, the current through the growler will increase when passing over a short-circuited coil.

The growler described below was built by me in 1921 and is still giving satisfactory service. It has been used steadily on stators ranging in inside diameter from about 6 in. up to 20 in. In Fig. 1 the growler is shown in position in the stator; for the sake of clearness only one coil is drawn in.

The winding of the growler acts as the primary of a transformer whose magnetic circuit is completed by the core of the motor being tested; the stator coil bridged by the two poles of the growler constitutes the secondary. If the stator coil is in good condition, there will be no change in the current passing through the growler winding, but if the coil is defective, the ammeter will indicate an increase in current and the defective coil will also heat up very noticeably.

If the slots spanned by the two poles of the growler are bridged successively by a strip of iron such as a feeler gage or a hacksaw blade, when bridging a slot containing a short-circuited coil, the strip of iron will be attracted to the core and will tend to vibrate. This latter test together with the heating of the defective coil, eliminates the necessity for connecting an ammeter in the growler circuit.

While using a growler the three motor leads should be disconnected from any current supply.

The dimensions of the growler shown in Fig. 1, are given in Fig. 2*A*. For service on a 110-volt, 60-cycle, alternating-current circuit, wind the growler with 150 turns of No. 13 B. & S. double-cotton-covered magnet wire. For use

ANSWERS *Received to Questions Asked*

on 220 volts use 300 turns of No. 16 wire.

Fig. 2*B* shows a somewhat larger growler. For this size use 60 turns of No. 5 wire when operating on 110-volt circuits, and 120 turns of No. 8 wire for 220-volt, 60-cycle operation.

Current should not be left on the growler any longer than necessary when it is not in contact with the stator bore, as the current through it will be increased considerably, owing to a decrease in the reactance, and may cause the growler coil to burn out in a comparatively short time. P. JUSTUS.
Cleveland, Ohio.

How Can These Bearings Be Made to Run Cool?

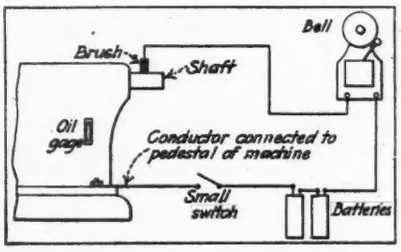
We have a motor-generator set that consists of a 25-kw. 125-volt, d.c. generator direct-connected to a 2,400-volt, three-phase, 1,800 r.p.m. induction motor. This set has three bearings of the ring-oiling type, the middle bearing being much larger than the end bearing. The latter bearings tend to run very hot, especially in hot weather, although the oil rings are functioning properly. The bearings never become so hot that the hand cannot be held on them for 20 to 25 seconds, but they are too hot for our peace of mind. The motor-generator set has been running almost continuously for four years, the oil being changed at intervals. The commutator and brushes are in good shape and the set is never fully loaded, running about three quarters capacity. My opinion is that the proper oil is not being used in the bearings in hot weather, and I should like to know whether a mineral oil should be used exclusively. If so, what characteristics should it have? I shall also appreciate any other information regarding the best methods of making these bearings run cooler.
McGaheysville, Ga. H.C.M.

IN ANSWER to H.C.M., my opinion is that he is not using oil of the proper viscosity, or that the correct clearance between the shaft and bearing is not being maintained, resulting in abnormal conditions.

Good bearing lubrication depends on the maintenance of an oil film between the shaft and bearing surfaces. This, in turn, depends on the right amount of clearance between these surfaces. The clearance that is usually allowed by one of the large machinery builders is as follows:

Diam. of Shaft, Inches	Clearance, Inches
½	0.0005 to 0.0010
1	0.0010 to 0.0020
2	0.0020 to 0.0030
3½	0.0030 to 0.0045
6	0.0045 to 0.0065

If the clearance is too small the oil film can not be maintained: then the two metallic surfaces will come in contact and a hot bearing will result. If the clearance is too great the shaft will pound, making it impossible to maintain a suitable film of oil. This condition will not only produce a hot bearing, but the constant pounding will in time ruin the bearing.



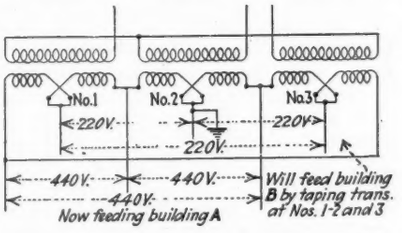
BREAKDOWN of the oil film, resulting in a metallic contact between the shaft and the bearing, is indicated by the ringing of the bell.

* * * *

A scheme that I have found to be very satisfactory for testing the effectiveness of bearing lubrication is illustrated in the diagram. THEODORE M. SMALL.
Auburn, Maine.

Will This Ground Cause Trouble?

We have a bank of 440-volt transformers supplying power to Building A, which contains 440-volt equipment. Operations will soon be started in Building B, which has all 220-volt equipment. Our transformers are large enough to supply both buildings and we plan to connect them as shown in the sketch, tapping them at points 1, 2, and 3, to obtain 220 volts. The local code requires that we ground the neutral (No. 2 wire) on the 220-volt circuit, but the 440-volt circuit does not have to be grounded. I should like to know, (1) whether this scheme is practicable. (2) Will the 440-volt equipment in Building A



be more likely to give trouble due to the grounding of the 220-volt service than if this circuit were not grounded? If so, what can we do about it?
Louisville, Ky. W.R.

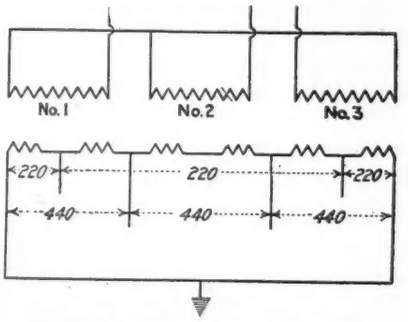
IN reply to W. R.'s question in the July issue in reference to proper grounding of a transformer bank, may I suggest a better conection to him?

If grounded according to his sketch a ground leak on the 440-volt circuit may readily interfere with the 220-volt circuit. The leakage from the 440-volt circuit being forced to return through the 220-volt taps.

On account of this interference there will be complications introduced which will make the locating of faults more complicated than need be. The regulation will be poor on the 220-volt side. I have tried the connection and know this to be a fact, although it looks very pretty on paper. The two circuits will be 60 deg. apart which might under some circumstances be a disadvantage.

My sketch indicates a preferable way to connect. It shows the high tension and 440-volt secondary, the same as to polarity as W. R.'s sketch, so he will have no changes to make excepting to take off his two 220-volt taps. One wire is common, so saving a little copper. Since the common wire is grounded there will not be the interference in case of accidental grounds on either circuit.

I note the code requirement that the neutral be grounded. On the sketch sent in by W. R., the secondary is delta connected with a corner grounded, and my circuit shows a corresponding con-



INTERFERENCE in the case of accidental grounds is eliminated on either circuit by the use of this ground connection.

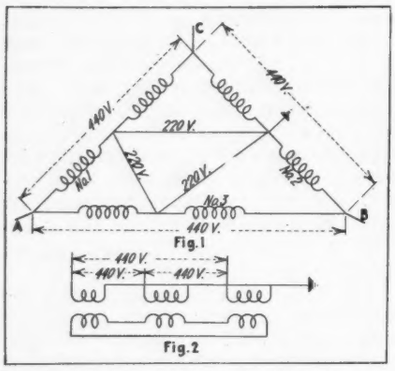
nection to ground. It is unlikely that there is really a code requirement, that the neutral of a polyphase system be grounded. This would require special transformers. EDWARD D. CARTER.
Engineer,
The Baylis Company,
Montclair, N. J.

THE scheme outlined by W. R. is quite feasible and practical, and can be followed out without fear of serious results.

Answering the second part of his question, one encounters the usual points brought up in any discussion of grounded and ungrounded systems. Fig. 1 represents the diagram given in the original question, but shows only the low-voltage side (which is the portion we are interested in) in a vectorial way, in order to give an idea of the true electrical relations. From this diagram it will be seen that the following voltage conditions to ground exist: (*a*) For the 220-volt circuit the maximum to ground is 220 volts. (*b*) On the 440-volt circuit we have 220 volts to ground from either lines *B* or *C*, and approximately 381 volts from line *A* to ground.

Another method of obtaining a ground would be to connect a bank of 440-volt transformers as shown in Fig. 2, with a grounded neutral on the 440-volt side and closed delta on the other side. This bank should be separate and the capacity need not exceed 10 per cent of the capacity of the system; it could be even

ANSWERS *Received to Questions Asked*



VECTORIAL RELATIONS (FIG. 1) of proposed system. Another method of obtaining a ground is illustrated in Fig. 2.

smaller. In this case there would be 127 volts to ground on the 220-volt system and 254 volts on the 440-volt system.

The best way to protect the grounded system would be to install an oil circuit breaker in the ground connection. The breaker should be tripped through a relay set to operate at a minimum ground current, as determined by an actual test. A bell alarm should be installed with the breaker to indicate when it opens, if a ground develops, so that the trouble may be investigated at once.

Such an arrangement would allow the system to continue in operation, even though a ground exists for the moment.

C. O. VON DANNENBERG.

New York, N. Y.

Can the Speed of this Motor be Changed Without Rewinding?

We have a Type ITC, Form M, 720-r.p.m., three-phase, 10-pole, 60-cycle, G.E., slip-ring motor with approximately 120 rotor slots and 90 stator slots, the intermittant duty horse power being 22. The rotor in this case is bar wound with end connections. As we wish to increase the speed of this motor without rewinding it, will readers kindly tell me how to reconnect the motor?
Seattle, Wash. W. M. P.

IN answer to W. M. P., the following pointers on changing the speed of a slip ring motor, may be of interest.

(1) With a wave winding on the rotor the coil pitch must be 100 per cent, and for the same number of poles as used on the stator.

(2) Consequent poles cannot be formed with a wave winding, nor with any lap winding in which the coil pitch is 100 per cent.

(3) If the rotor has a lap winding and 80 per cent or less coil pitch, it can be reconnected for 20 consequent poles.

(4) Or, the end connectors of a bar and end connector winding can be removed, reformed, and the rotor reconnected for 12, 14, 16, etc., poles. A corresponding change must be made in the stator and the voltage conditions satisfied.

(5) With a bar and end connector type of wave winding it is possible in some cases to remove the end connectors and reform them, reconnecting them for a different number of poles.

(6) When reforming the end connectors a low speed only can be obtained as the connector cannot be stretched for a longer coil pitch.

(7) In W. M. P.'s case, the only practical method of changing the speed would be to remove all end connectors, develop two end rings of a suitable resistance, and change the motor over to a squirrel-cage type.

A. M. Dudley's book Connecting Induction Motors contains some data on calculating the resistance of end rings for squirrel-cage rotors.

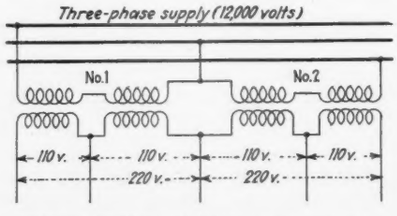
A. C. ROE.

Renewal Parts Engineering Dept.,
Westinghouse Electric & Mfg. Co.,
East Pittsburgh, Pa.

Connecting Single-Phase Transformer to Three-Phase Supply

We have two 75-kw., 12,000/220/110-volt single-phase transformers of the same make. One of these is used to supply a lighting load and the other is held as a spare. Additions to our plant will make increased capacity necessary, and I wish readers would show me how to connect these two transformers to our three-phase supply so that we can obtain 220 and 110 volts.
Vancouver, B. C., Canada. A.M.

IN ANSWERING the question asked by A. M. in a recent issue, the accompanying sketch shows a way in which the two transformers could be connected to obtain 110-220 volts from the 12,000-volt primary supply. With



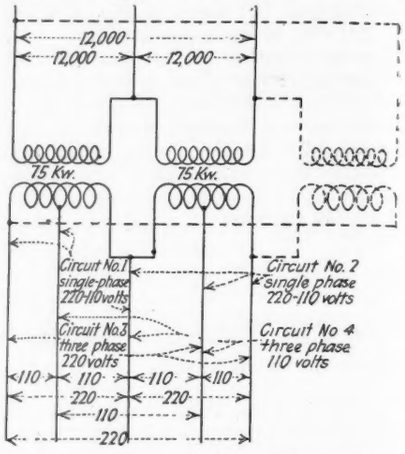
CONNECTION DIAGRAM of two single-phase transformers on a three-phase supply circuit.

this connection, which is called the V. or open-delta connection, the two 75-kw. transformers would be overloaded 15.5 per cent at a secondary load of 150 kw. at 100 per cent power factor.

RUDOLPH ERICKSON.

City Electrician,
Two Harbors, Minn.

IN ANSWER to the question by A. M., for a connection using two 75-kw. transformers, the accompanying sketch is self-explanatory. In case you have no three-phase equipment but wish to take power from a three-phase line, then the single-phase loads should be divided somewhat equally between circuits No. *1* and No. *2*. The sketch shows an open-delta circuit with dotted



TRANSFORMER CONNECTIONS for taking service from a three-phase supply line for voltages desired and how a third transformer (see dotted lines) may be added in case of expansion.

lines for a third transformer which will make a closed delta in case of still further expansion. This third transformer will assist only on the 220-volt, three-phase loads and one combination of 220-volt, single-phase load.

EARL R. WITZEL.

Research Department,
Kohler Company,
Kohler, Wis.

Size of Conductors for Three-Phase Circuit

Can some one tell me what size of copper conductors will be required in a three-phase circuit to transmit 440 amp. a distance of 600 ft. The voltage at the bus in the power house is 2,300 volts, and 2,200 volts are required at the distribution center 600 ft. distant.
Louisville, Neb. D.F.Z.

IN THIS question D. F. Z. fails to state whether he intends to use interior or exterior lines, or whether they will be located overhead or underground. However, as a general answer we find by referring to the National Electrical Code that if he uses rubber-covered wire it must of necessity be of 500,000 circ.mil area, whereas if weatherproof wire were used it would have to be of 300,000-circ.mil area. These figures are based on the carrying capacity of solid wire.

The use of wire of the sizes indicated would not give 100 volts drop and I trust that D. F. Z. is not contemplating using a smaller wire in order to obtain this drop, as excessive cable heating would result. Personally, I would use 300,000-circ.mil cable.

E. J. MORRISSEY.

Asst. Chief Engineer,
Western United Gas & Electric Co.
Aurora, Ill.

AROUND THE WORKS

Reconditioning Plant Equipment with an Electric Arc Welder

SOMETIME or other every plant engineer or superintendent of maintenance is brought face to face with the problem of maintaining boilers in service that have worn or corroded at critical points. Usually it is the fatigue of the boiler plate caused by its constant subjection to high temperatures that brings about failure. Before the advent of the electric arc welder the problem was a difficult one to solve for it frequently meant that the units to be repaired had to be taken off the line for a long period of time and even sometimes removed from the settings. In installations where the total horsepower capacity of the boiler plant was required for power generation and plant heating, such reconditioning meant a partial or even complete suspension of production.

Since the day of the commercially practicable arc welder these contingencies in industrial plants have offered very much less difficulty of solution. With an electric arc welder, new plates can be installed on any unstayed surface. Every man who has spent any considerable period in contact with steam boilers is well aware what a boon this is.

* * * *

FIG. 1—SECTION of vertical tubular boiler showing new sheet welded in place. This new sheet was single-riveted to the mud ring electrically welded along the circumference and reinforced with ½-in. flat steel.

THIS SECTION *is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.*

* * * *

During the time that we have been serving industry as welding engineers and contractors, we have frequently been called upon to perform boiler maintenance work. Among the jobs that have fallen to our lot was one shown in Fig. 1. In this instance there were three 90 in. diameter vertical tubular boilers that had been in service for a great many years. The original sheet below the bottom of the mud ring had corroded and worn away to 80 per cent of its original thickness. We were asked to fit a new $\frac{7}{16}$-in. sheet in its

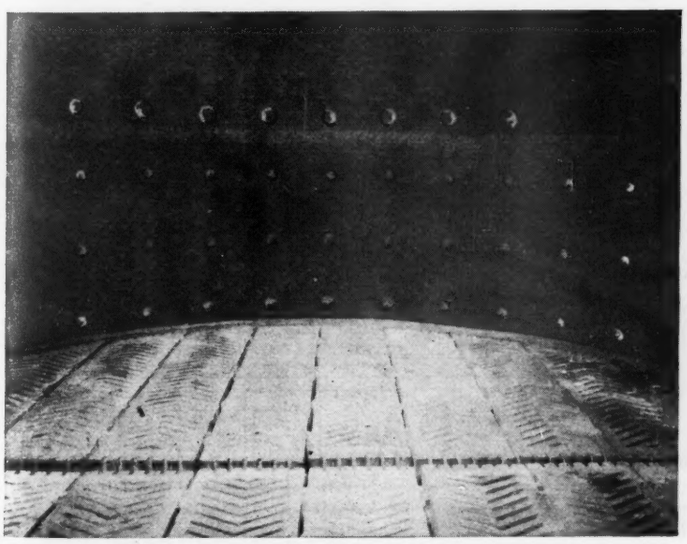
As a preliminary to installing the new sheet, the old one was removed and the bottom edges of the next sheet above it and below it were chamfered for welding. The new sheet was then put in place, single riveted to the mud ring and electrically welded over the entire circumference of the joints. The type of weld used was, as indicated by the chamfering, a butt weld. To reinforce this, a piece of ½-in. flat steel was welded on the outside. The equipment used was that manufactured by The Lincoln Electric Company, Cleveland, Ohio.

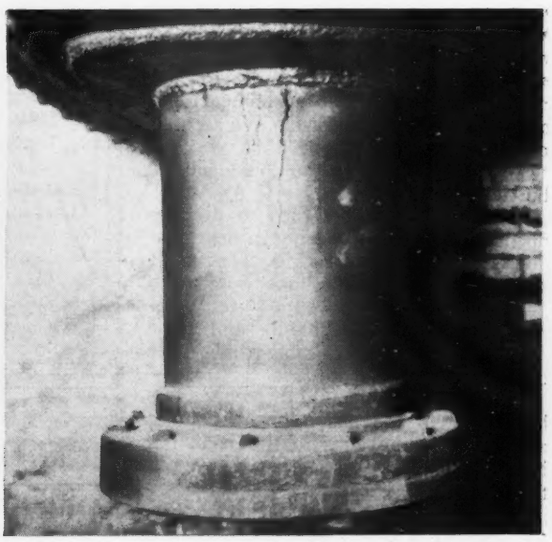
The work of repairing these boilers consumed the minimum number of hours and was carried on without any difficulty whatever. Had it been necessary to make a tight joint by riveting, the labor, trouble and expense would have been multiplied many times.

On another occasion we were called upon to do the work necessary to convert three horizontal return tubular boilers that had passed their usefulness as high-pressure units. They were to be altered to generate low-pressure steam at 15 pounds for heating purposes. When the boilers were operating at high pressure there was a 2½-in. blow-off connection on the rear of each. These connections were removed, and 14-in. flanges were fitted and welded to the shells. Nipples were then welded to the flanges and elbows for connection to the return line, assembled and arc welded in place. Here again repair riveting would have been a laborious and involved process whereas by welding, the work was done in a straightforward and simple way at very little expense. The new welded nozzle is shown in Fig. 2.

* * * *

FIG. 2—REPAIR riveting would have been a laborious job here. Electric arc welding equipment was used to good advantage in reconditioning high-pressure units for low-pressure heating purposes.





To repair locomotive fire box sheets that fail at the edge of the fire line with a riveted patch is both expensive and arduous. The sheets can, however, be built up in a manner that is entirely satisfactory by simply laying on new metal with an electric welder. Such a repair will restore the fire box to its original strength and will add many years to its life of service. The weld metal will ably withstand the pressure, the vibration and the shock of the heavy fire tools.

Reconditioning of boilers is but a very small part of the maintenance work that can be done with an electric arc welder.

THOMAS R. BERG.
The J. K. Welding Company, Inc.
New York City

Water-Soaked Cable Jacked Out of Conduit

AFTER the hurricane here in 1926, this shop had a busy time overhauling the wiring of quite a few apartment hotels and other buildings, some of which were cheaper to rewire entirely than to try to patch up.

However, a cable pulling job in one large apartment hotel remains in my mind, as one of the hardest pulls it has ever been my experience to have.

Being only one hundred yards from the sea, it got as good a washing as any of them—indeed there were 6 ft. of sand left in the basement and we had to dig out half of the meters and apartment switches in the meter room.

The current was fed from transformers in the transformer room to a 400-amp. three-pole switch on the slate switchboard, and from there it fed with three 500,000-circ.mil cables in 3-in. conduit laid in the concrete floor with an ell turned up on each end, to the meter room 50 ft. away terminating in a type *A* condulet with 3-hole porcelain covers.

When we had dug the ends of the cable and conduit from the sand, it was seen that the insulation was soggy and swollen, so we decided to pull it out and replace it with new cable.

After removing the condulets and hooking onto the 500,000-circ.mil cable with two double blocks and new 1-in. manila rope, six of us toiled on with the expectation of pulling it out immediately, but it didn't budge an inch. We secured more help, until at one time we had twenty men pulling on the double blocks, but without success.

We were about resigned to digging up the concrete and putting in new conduit and cable, but as a last resort—I visited the local telephone company's yards and there borrowed a 10-ton pole-pulling jack, some 6,000-lb. and some 10,000-lb. messenger cable and cable clamps.

Doubling the 6,000-lb. messenger, we hitched it to the cable in the conduit and clamped the ends to the jack, but it snapped like a thread when we put three men on the handle.

Changing to the 10,000-lb. messenger, we doubled it and hooked on, and then with four men on the jack, the solid iron handle bent, and one strand of the messenger snapped, but the cable in the conduit started to move, only a fraction of an inch, however, but it was broken loose at last.

H. G. MILLICAN.
Foreman,
Miami Electric Service Company,
Miami, Fla.

Auxiliary Switches On Discharge Valves Control Pump Motor Circuits

IN A RECENT installation of three similar 50-hp. motors, each connected to Coniflo pumps, the control was arranged so that the motors could be started only when the valves shown in Fig. 1 were fully open.

The reason for this type of control was to prevent the motors from being started with the discharge valves closed.

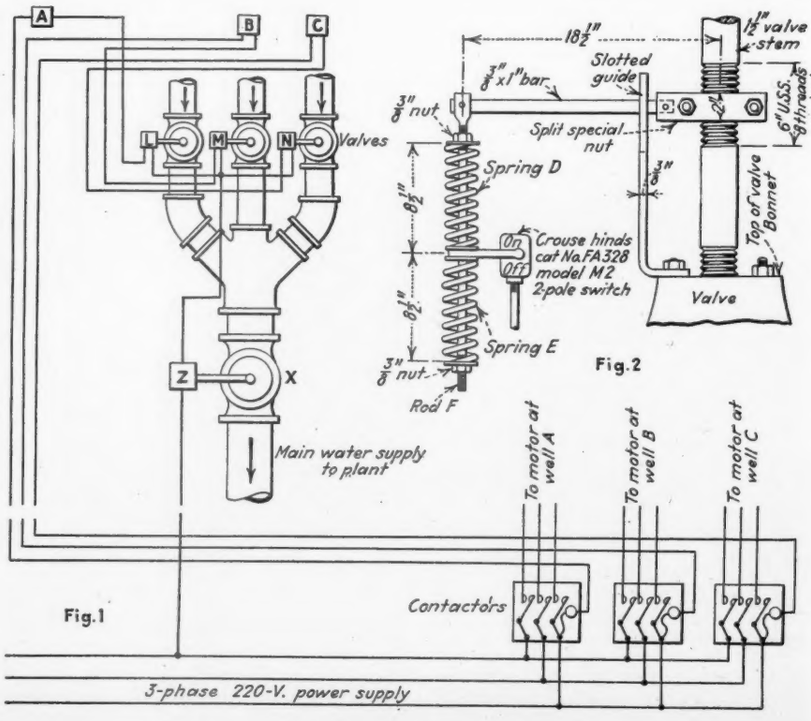
The motors were intended to be thrown directly across the line. A single-pole switch at each motor in connection with a three-pole contactor at the plant, was used for this purpose. Normally, the switch at the motor is closed; the motor being controlled by the second switch *L, M* or *N* by operating the valve.

The main valve *X* controls a master switch *Z* which supplies current to the control switches *L, M, N* and *A, B, C,* as shown in the accompanying illustration.

All the valves were remodeled as shown in Fig. 2. All switches are identical and are connected single pole.

* * * *

FIGS. 1 AND 2—SCHEMATIC wiring diagram of control circuits and close-up of auxiliary switch showing materials used and assembly.

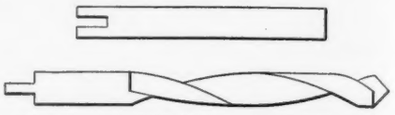


This particular make of switch is of the quick-make and quick-break type. The springs *D* and *E* allow minor adjustment by means of the ⅜-in. nuts on rod *F*.

CHAS. A. PETERSON.
Chief Electrician,
Fairbanks Exploration Company,
Fairbanks, Alaska.

Shank Extension for Deep-Hole Drilling

IN THE May issue of *Industrial Engineering,* I read the article by Donald Hampson, plant superintendent, Morgan & Wilcox Manufacturing Company, Middletown, N. Y., on "LENGTHENING A DRILL SHANK."



THE TOOL STEEL for the shank extension is slotted to take the milled end of the stock drill.

* * * *

This called to my mind an instance where it was necessary to drill a ⅝-in. hole through a piece of cold rolled steel 24 in. long, lengthwise. The case was just as Mr. Hampson stated.

We did not have a drill long enough in our tool room, so I proceeded to make one as per the accompanying sketch. A ⅝-in. stock-sized drill was taken and milled on the end the same as a taper shank, leaving it, however, ¼ in. thick. A piece of ⅝ in. tool steel was then fitted on this end by slotting the end as shown. It was then brazed with the aid of an oxy-acetylene torch.

Hohokus, N. J. GARRET WHITE.

NEW EQUIPMENT

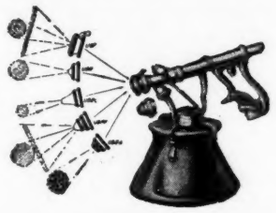
For Plant Operation and Maintenance

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Air Brush

A RECENT circular announces the introduction of a new air brush known as the Paasche Lo-Hi pressure feed air brush by the Paasche Airbrush Company, 1909-1923 Diversey Parkway, Chicago, Ill.

This new machine is a multiple head air brush with a pressure feed attachment. It is claimed that it operates on less than one-half the air consumption required by any other standard syphon or gravity feed spraying device and at one-half to one-quarter the air volume generally required. Multiple heads in five sizes, each in five different types provide a wide range of air painting with this air brush. A quarter turn gradually switches from a round to a wide smooth spray. The needle floats in its own bearing, and is made of stainless steel in standard sizes for all tips. A swivel slanting fluid inlet permits a rapid and straight flow and makes cleaning simpler. Skin or lumps can be blown back and out with its own air pressure, eliminating the usual disassembling for cleaning.



Paasche Lo-Hi Pressure Feed Air Brush

The compression packing, self-lubricating, has automatic take-ups preventing sticking, gumming, leaking and waste of time and solvent for soaking, it is claimed. The air brush is equipped with a two-finger steel trigger.

The brush operates on air pressures ranging from 6 lb. to 125 lb.—from 2 cu.ft. to 20—by changing a head. All parts and units are interchangeable.

Bus Supports

A NEW line of 220/4,500-volt bus supports for exciter buses, switchboard wiring, customers' transformer vaults, industrial plant wiring, etc., has been developed by the Delta-Star Electric Company, Chicago, Ill.

A typical installation at the Armour & Company Chicago plant is pictured.

The dry flashover is 38,000 volts. Ultimate tensile strength 3,000 lb. and ultimate cantilever strength applied one inch above the top of the insulator is 1,160 lb.

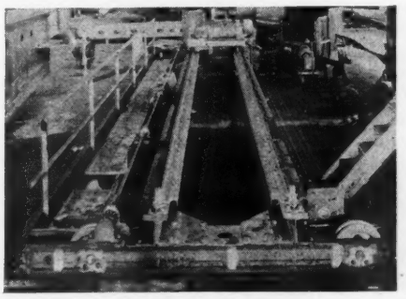
Delta-Star Electric Company Bus Supports

The insulators are wet process porcelain dark brown glaze and have smooth sides instead of the conventional corrugated surfaces.

Arc Welded Crane

A NEW design of overhead traveling crane in which the bridge girders, end trucks and trolley are constructed by arc welding is announced by the Cleveland Crane and Engineering Company, Wickliffe, Ohio.

The illustration reproduced herewith shows a 5-ton, 38-ft. 9¼-in. span crane of the I-beam girder type. Each girder is reinforced throughout its entire length by angles arc welded to the standard I-beam sections, it is said. The girders are attached to the end trucks by the notched or shoulder construction designed to prevent weaving. To facilitate shipping the girders and trucks are disassembled. The field connection is made by bolts but additional arc welded reinforcement is recommended to secure maximum regidity.



Cleveland Crane and Engineering Company Arc Welded Crane

The end trucks themselves are built up of two standard channel sections joined by arc welding. Roller bearings are used on this crane permitting rapid acceleration and lower power consumption. Each trolley frame is made of a standard channel with arc welded braces under each bearing point. Gear guards are arc welded as is also the hand rail on the foot bridge and the bearing supports for the bridge drive shafts.

New Control for Automatic Arc Welding

AN improvement in the control equipment used with the automatic arc welding head, by means of which the feed of electrode wire is stopped a short time before shutting off the welding current at the end of the weld, is announced by the General Electric Company, Schenectady, New York. This serves two purposes: first, it clears the electrode from the weld, and second, it fills in the crater which is inevitably left at the end of the weld when the arc is cut off short.

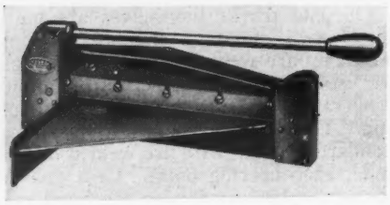
General Electric Company Automatic Arc Welding Head Control

According to the manufacturer, it is always desirable to have the electrode clear of the weld when removing the work from the clamping fixture, to prevent the end of the wire from dragging.

The General Electric control panel for its automatic welding head is controlled by a start and stop push button station. Mounted on the panel is a line contactor of suitable size for the welding current, an arc voltage regulating relay, and relays for controlling the electrode motor and for clearing the electrode from the weld. The rheostat for controlling the arc voltage and the speed of the electrode motor is mounted on the outside of the sheet metal inclosing cage. A small meter panel is used for indicating the arc voltage and welding current.

Belt Cutter

A NEW 10-inch open end belt cutter has been announced by the Clipper Belt Lacer Company of 974-1042 Front Avenue, N. W., Grand Rapids, Mich.



Clipper Belt Lacer Company Open End Belt Cutter

This new cutter will cut and square any make of belting up to and including 10 in. in width with a slight pressure on the handle. This machine is made of malleable castings, cold rolled steel and tool steel. As a measure of safety, it is impossible to raise the blade high enough to become dangerous.

Disconnecting Switches

A NEW line of unit type 7,500-volt to 37,000-volt disconnecting switches of the multi-blade and tongue types of contact have been developed by the Delta-Star Electric Company, Chicago, Ill.

They are made for straight front or back connections or combinations to meet various conditions.

The insulators are of the unit type form, interchangeable with other unit type disconnecting switches and bus supports.

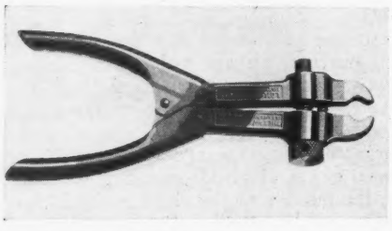
In the back connected type the insulators are secured to the steel base by means of a removable clamp, enabling prompt replacement—should this become necessary.

Pliers

PLIERS which take their name Lok-Jaw from the arrangement whereby the jaws may be locked to nuts, bolts, and other objects in the manner of a hand vise, have been added to the line of the Lawson Manufacturing Company, Cleveland, Ohio.

The device is arranged with an adjusting screw at the jaw and the compound lever is said to provide a one-ton grip at the jaws. The latter are designed to fit round, square, or hexagon objects.

The pliers may be clamped to a loose nut or bolt head in an inaccessible place, and will keep the nuts or bolts from turning while it is being loosened or tightened with a screw driver or wrench. The jaws are of steel forgings, heat-treated; the handles are of flexed steel and have knurled grips. In the size illustrated, the 8-in., the maximum jaw opening is $\frac{3}{4}$ in.

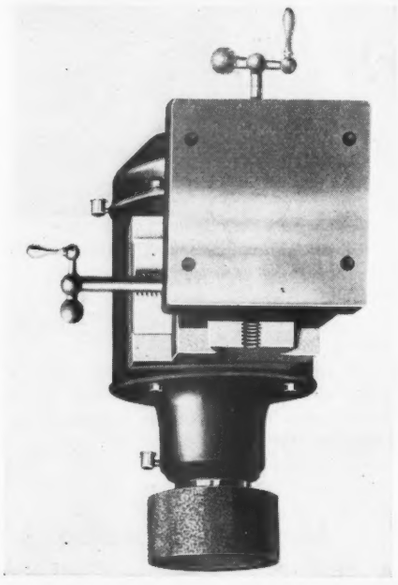


Lawson Manufacturing Company Lok-Jaw Pliers

Vertical Spindle Grinder

THREE new types of vertical spindle grinders have recently been placed on the market by the Hisey-Wolf Machine Company, Cincinnati, Ohio. The illustration shows the vertical spindle type with a double slide adjustment.

These machines can also be furnished with a vertical slide adjustment and a horizontal slide adjustment. They were designed primarily for thrust grinding with the spindle in a horizontal position or with the grinding wheel swung down at any angle. The first types are made in 1, 2 and 5 hp. sizes for alternating current and in 3 hp. for direct current. Special ball bearing construction is used throughout and the bearings are constantly lubricated in an oil bath and fully inclosed in leak-proof chambers.

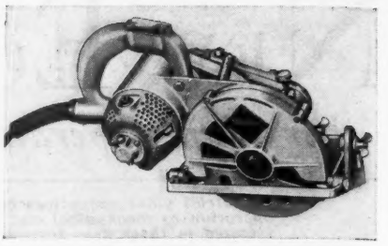


The Hisey-Wolf Machine Company Vertical Spindle Grinder With Double Slide Adjustment

Hand Saw

A NEW small electric hand saw with a cutting capacity of 2 in., and equipped with a safety guard, has been introduced by the Wappat Gear Works, Inc., 7522-26 Meade Street, Pittsburgh, Pa.

The most noteworthy features, according to the manufacturer, are the safety guard, dominant ruggedness of design, and adaptability to a great variety of uses. The lower guard, an exclusive patented feature, which completely incloses the saw blade, opens gradually by telescoping into the upper guard as the saw is pushed into the material, and immediately snaps shut as the cut is finished, thus affording protection to the operator and the saw blade.



Wappat Gear Works, Inc., Small Hand Saw

It is built in three models; one for plain square cutting; one for bevel cutting; and one with an adjustable dado cutter for grooving On all three models the shoe is adjustable vertically, making it possible to set the saw to cut to any required length or depth.

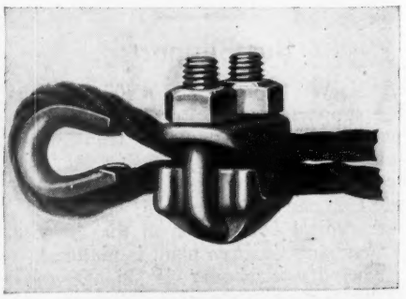
It is further added that a high speed universal motor, fan-cooled, mounted on ball bearings furnishes the power and shoots a blast of air to the front of the saw, clearing the sawdust away and making it possible to follow a line accurately. The saw shaft, mounted on taper rolling bearings, is driven by helical gears which are mounted on ball bearings, all completely inclosed and running in grease. A double pull non-arc switch is mounted on the handle within convenient reach. The frame is all aluminum and all exposed steel parts are rustproof.

Cable Clip

A CABLE clip with a considerably larger holding surface has been put into production, in a full range of sizes by the Eureka Metal Products Corporation of North East, Pa.

It is a patented clip, which according to tests, has shown its ability to carry three times the maximum load of an ordinary clip—and to give equally good results both on wire rope and messenger strand.

Besides giving a larger holding surface the manufacturer claims that the Eureka Clip saves cables, but there is no distortion of the cable whatever. The large surfaces on both the top and bottom plates are grooved for the lay



Eureka Cable Clip

of the cable, so that neither of the cables is gripped by the U-bolt.

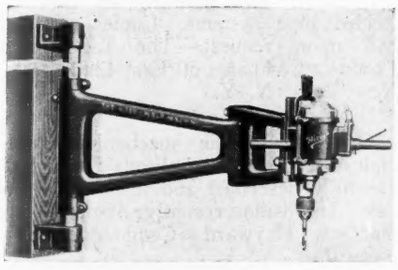
The Eureka Clip according to the manufacturer, gives triple safety because of its triple grip upon the cable. This is perhaps the most important feature from the standpoint of most users, especially structural erectors with whom "safety first" is always a prime consideration.

Radial Drilling Arm

A NEW double radial arm which can be used on all Hisey portable electric drills up to and including $\frac{7}{8}$-in. capacity, has been introduced by the Hisey-Wolf Machine Company, Cincinnati, Ohio.

A lever feed is operated through rack and pinion the same as a drill press, thereby permitting a positive and sensitive control without the slightest fatigue to the operator, it is stated. The motor-holding brackets are designed so that the portable drill can be attached without removing a single part of the machine. This feature is a great time saver and a protection against loss of parts. This radial arm is mounted on a ball thrust bearing (inclosed and dustproof) which reduces friction to a minimum and permits quick and easy adjustment.

It is also stated that by means of the individual swivel clamps, either the long or short arms can be locked independently, whereas, if the work requires, both arms can be locked in any fixed angular position. The full arm



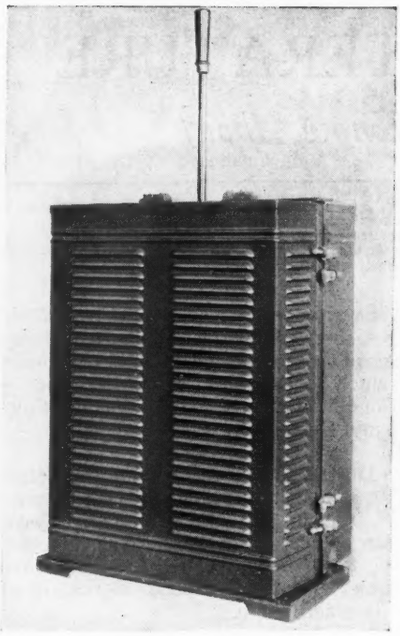
Hisey-Wolf Machine Company Radial Drilling Arm

length will swing to an arc of more than 240 deg. The short arm has an angular adjustment of 245 deg. The maximum arm reach from column to drill spindle is $36\frac{3}{4}$ in. The net weight of this machine is 215 lb.

Dinkey Controller

THE 1928 model of the E. C. & M. Dinkey controller has been announced by the Electric Controller & Manufacturing Company, 2700 East 79th Street, Cleveland, Ohio.

A list of the outstanding features of this controller includes the following: Ebony asbestos is used in place of slate. The ventilated contacts are raised $\frac{5}{16}$ in. from the dial plate. The contact supporting lugs are attached to the front of the dial and are removable from the front. The contact lug has a single



E. C. & M. Dinkey Controller

square-head set screw to tightly clamp the lead-wire. The controller has a welded steel frame. The main arm is carried on ball bearings. It has a smooth center top, of notched top, and roller type. The bearing-spider casting supports the dial as well as the arm, and quadrant bearings, insuring correct alignment and even contact.

It is also added that the controller is now equipped with nickel alloy resistors, guaranteed against breakage in shipment and in service for one year.

Wrench Set

ANOTHER new Williams-Husky Combination Wrench Set has been made possible by the recent reciprocal sales arrangement between J. H. Williams & Company, Buffalo, N. Y., and the Husky Wrench Company, Milwaukee, Wis. This arrangement enables each company to merchandise in combination sets the other's quality open-end, or socket wrenches.

The Williams-Husky Electrical Set No. 287 is claimed to be the only complete assortment on the market combining open-end and socket wrenches to service the electrical equipment of all makes of cars, for general electrical and radio work, and for all delicate adjustments. The set contains seven Williams Midget "Superrenches" (Chrome-Molybdenum steel), sizes $\frac{5}{32}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{11}{32}$, $\frac{3}{8}$, $\frac{7}{16}$, and $\frac{1}{2}$ in., each wrench having two openings of the same size—but at different angles (15 deg. and 75 deg.).

The Husky wrenches included in the set are 8 "Baby" sockets, tapered for work in close quarters, sizes $\frac{5}{32}$, $\frac{5}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{11}{32}$, $\frac{3}{8}$, $\frac{7}{16}$, and $\frac{1}{2}$ in., together with a 5-in. combination Tee and a $4\frac{1}{2}$-in. handy grip. The set is packed in a convenient and durable metal box, size $5\frac{1}{4}$x$2\frac{3}{8}$x1 in. high.

Combination Switch and Outlet

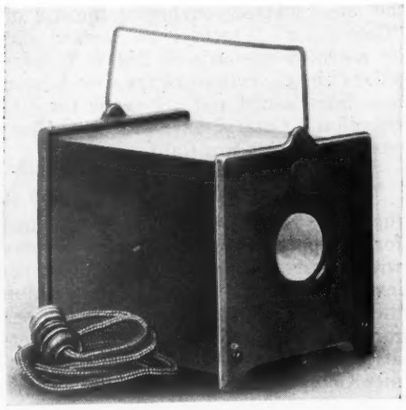
MARKETING of a new, single-gang combination of tumbler switch and convenience outlet has been announced by Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y. It has been designed to fit any standard, gang-switch outlet box, and is intended for use in places where a switch is needed to control a light, with an outlet to accommodate an electrically operated appliance. The tumbler switch controls the lighting fixture, whereas the convenience outlet is wired separately, so that current is always available.

Portable Furnace

A NEW electric furnace, known as the Nabob electric portable furnace has been announced by the Nabob Electric Company, of New York.

According to the manufacturer it is a small resistance type electric furnace $7\frac{1}{2}$ in. long, 6 in. wide and $6\frac{1}{2}$ in. high, weighing about 10 lb. It is provided with a carrying handle and a 6 ft. extension cord which may be plugged into any 110 volt electric light or power circuit. The current consumption is only 440 watts or less than three 150-watt electric lamps.

The resistance element is of nichrome wire of the highest quality obtainable. It is wound on a 2 in. diameter round steel tube which forms the heating chamber which is 6 in. deep.



Nabob Electric Company Portable Furnace

Any soldering iron or other object not more than $1\frac{13}{16}$ in. in diameter can be quickly heated, for while the furnace was designed primarily for the purpose of heating soldering irons, it is readily adaptable for many other uses.

It is also added that the temperature is automatically controlled and never reaches a point high enough to burn the point of a soldering copper and to further protect the soldering point, the temperature at the inner end of the heating chamber is not permitted to run as high as at the center where the body of the iron or copper rests.

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

THERMOMETERS — Catalog No. 93, just off the press, fully describes the applications and types of ground resistance thermometers, as applied to modern industry.—The Brown Instrument Company, Philadelphia, Pa.

CRANES—The new "Built for Service" crawler crane book No. 995, covers the complete Link-Belt line of gasoline, Diesel and electric crawler cranes of capacities up to and including the two cubic yard heavy duty machines as well as standard locomotive cranes.—Link-Belt Company, 10 South Michigan Avenue, Chicago, Ill.

MOTORS—Folder G.E.A.861 describes Class BF Motors and Control, types BG1 horsepower, GD3 and 5 horsepower and form LA. This equipment is for use with direct current, 230 volts, 1150 r.p.m. It is compound wound, totally inclosed, for continuous duty, with a 75 deg. C. rise.—General Electric Company, Schenectady, N. Y.

TRACTORS—Four new books which, according to the announcement, present the latest methods involving the use of "Caterpillar" Tractors as worked out by users of upwards of 25,000 "Caterpillars" in all sections of the world, have now been issued and are ready for distribution.—Caterpillar Tractor Company, San Leandro, Calif.

SPRAY COATING—"Spray Coating" is the name of a new booklet just issued for the purpose of acquainting owners with the dangers which beset the careless user of this process. In addition there are numerous helpful suggestions for the safety and welfare of the operator.—Hartford Accident and Indemnity Company, Hartford, Conn.

TORFOLEUM—This insulating material, which it is said, has been in use in Europe for many years for ice making plants, cold storage plants, refrigerator cars and refrigerator boxes, is described in a new booklet now ready for distribution.—Pennrich & Company, Inc., 29 Broadway, New York, N. Y.

TRANSFORMERS—A new 48-page booklet contains an interesting pictorial trip through the new Maloney transformer plant. Various stages in the construction and assembly of this equipment are shown and described.—Maloney Electric Company, St. Louis, Mo.

SWITCH HOUSES—Advance bulletin No. 548-3 contains an illustrated description and specifications of Condit switch houses for outdoor service.—Condit Electrical Manufacturing Company, Boston, Mass.

DOWEL SLEEVE—Buckling and cracking of concrete roads can be prevented by the use of the Cleveland Dowel Sleeve, according to the folder announcing this device.—The Cleveland Container Company, 10630 Berea Road, Cleveland, Ohio.

HEATERS—The "Falcon" line of specialties for electric ranges, including open radiant oven heaters, are described in Bulletin No. 130.—H. O. Swoboda, Inc., 3400 4th Street, Pittsburgh, Pa.

WINDOWS—A new bulletin entitled "Truscon Continuous Steel Windows and Mechanical Operators" is now ready for distribution. A copy may be had upon request.—Truscon Steel Company, Youngstown, Ohio.

LIGHTING FIXTURES—"New Achievements in Lighting Equipment" is the name of a new booklet describing the White line of lighting fixtures, including the new daylight unit.—The O. C. White Company, 15-21 Hermon Street, Worcester, Mass.

ARC WELDING—Some of the many uses to which this process is put are shown in a new 28-page booklet bearing the designation G.E.A.-423 A.—General Electric Company, Schenectady, N. Y.

SUPERHEATER. — Bulletin T-1 describes and illustrates the design, construction, and application of the Elesco Superheater to power plants.—The Superheater Company, 17 East 42nd Street, New York, N. Y.

AIR BRUSH.—A recent bulletin describing the Eclipse Air Brush contains some very interesting examples of the comparative costs of hand and air brush painting.—Eclipse Air Brush Company, 79 Orange Street, Newark, N. J.

MATERIAL HANDLING EQUIPMENT.—A catalog of material handling equipment, including lift trucks, portable elevators, platforms and racks, hand trucks, carts and barrows, has been published and is now ready for distribution.—Lewis-Shepard Company, Watertown Station, Boston, Mass.

PUMPS.—Bulletin No. 212, June, 1928, contains a description of Pennsylvania multi-stage centrifugal pumps, Class O.M.S. The bulletin also contains a description of the Pennsylvania high pressure boiler feed pump.—The Pennsylvania Pump and Compressor Company, Easton, Pa.

LIGHTING EQUIPMENT.—A reference wall chart for convenience in specifying and ordering by enabling one to select at a glance the right type, size and catalog number of any Benjamin reflector or other item of industrial lighting equipment has been published and is now ready for distribution. A copy may be had upon request.—The Benjamin Electric Manufacturing Company, 128 South Sangamon Street, Chicago, Illinois.

ARC WELDING.—A new bulletin recently issued describes the Fuzon Line of arc welders.—Fusion Welding Corporation, 103rd Street and Torrence Avenue, Chicago, Illinois.

SWITCH CLOSING MECHANISM. — Type MO-1 motor operated closing mechanism for oil switches and circuit breakers is described and illustrated in advance bulletin No. 473.—Condit Electrical Manufacturing Corporation, Boston, Mass.

PIPING.—"Oxwelded Industrial Piping" is the name of the new booklet describing the details of construction, and repair and maintenance of Oxwelded pipe systems. Copies may be had upon request.—The Linde Air Products Company, 30 East 42nd Street, New York, N. Y.

COUPLING. — The mechanical principles of Fasts self-aligning coupling are fully described and illustrated in a new broadside recently issued.—The Bartlett Hayward Company, Baltimore, Md.

HYDRAULIC PRESS—The detailed use of this interesting and important piece of equipment in several industries is fully described and illustrated in the current issue of "The Hydraulic Press."—The Hydraulic Press Manufacturing Company, 20 East Broad Street, Columbus, Ohio.

ACETYLENE EQUIPMENT. — Form 462A is a 56 page bulletin on oxy-acetylene equipment for welding, cutting, brazing, lead burning, heating, and decarbonizing. — Oxweld Acetylene Company, Carbide and Carbon Company Building, New York, N. Y.

CONVEYOR EQUIPMENT.—"A general catalog of Saginaw Products" including conveyor equipment, casters, and trucks of all kinds, has recently been published and is now ready for distribution.—Saginaw Stamping and Tool Company, Saginaw, Michigan.